CDC 4E051

Public Health Journeyman

Volume 1. Introduction to Public Health

Air Force Institute for Advanced Distributed Learning

Air University

Air Education and Training Command

Author: SSgt Robb T. Gudgel
USAFSAM
USAF School of Aerospace Medicine (AFMC)
Brooks Air Force Base, Texas 78235-5252

DSN: 240-3731
E-mail address: robert.gudgel@brooks.af.mil

Instructional Systems Specialist: Pamel G. Brown

Editor: Sherry M. Topper

Air Force Institute for Advanced Distributed Learning
Air University (AETC)
Maxwell Air Force Base, Gunter Annex, Alabama 36118–5643

In the 4E031 course you learned the facets of our career field. You also discovered that there are many challenges and opportunities in our broad range of duties. In this course, you will study the building blocks of our career field. Volume 1 gives you the basics of Public Health. In Volume 2, you will study the principles of epidemiology and the control of communicable diseases. There will also be a unit on medical entomology. Volume 3 deals with the Occupational Health Program. It covers everything from hazards and shop evaluations to the hearing conservation and fetal protection programs. In Volume 4, the topic changes to food inspection. It covers food technology, food procurement, the receipt and surveillance inspection programs, and facility sanitation. The focus is on the basics of facility inspections and critical inspection items as defined in the FDA Food Code. The final volume, Volume 5, explains our role in contingency operations. It gives historical scenarios and areas to consider in developing plans to respond both to peacetime disasters or accidents and to wartime emergencies. There is also a separate unit covering field sanitation and hygiene.

Unit 1 of this volume presents the mission and organization of the USAF Medical Service, the Aerospace Medical Service, and Public Health. Unit 2 discusses the basics of biology. Unit 3 covers anatomy and physiology; Unit 4 contains information about medical records..

Code numbers on figures are for preparing agency identification only.

The use of a name of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Air Force.

To get a response to your questions concerning subject matter in this course, or to point out technical errors you find in the text, unit review exercises, or course examination call or write the author using the contact information on the inside front cover of this volume.

NOTE: Do not use the IDEA Program to submit corrections for printing or typographical errors.

Consult your education officer, training officer, or NCOIC if you have questions on course enrollment or administration, *Your Key to a Successful Course,* and irregularities (possible scoring errors, printing errors, etc.) on the unit review exercises and course examination. Send questions these people cannot answer to AFIADL/DOI, 50 South Turner Blvd, Maxwell AFB, Gunter Annex AL 36118–5643, on ECI Form 17, Student Request for Assistance.

This volume is valued at 15 hours and 5 points.

NOTE:

In this volume, the subject matter is divided into self-contained units. A unit menu begins each unit, identifying the lesson headings and numbers. After reading the unit menu page and unit introduction, study the section, answer the self-test questions, and compare your answers with those given at the end of the unit. Then do the unit review exercises.

Page

Unit 1. USAF Medical Service Mission and Organization

THE public health career field is very broad in scope. The information you received during apprentice training is basic to understanding your mission, responsibilities, and specific duties as a Public Health Apprentice. As in all serious undertakings, your reward will be equal to the effort you place in your duties.

1–1. The USAF Medical Service and Aerospace Medical Service

You'll start by taking a look at the USAF Medical Service and learn what overall mission the public health team helps accomplish.

001. USAF Medical Service mission and organization

Mission

Aerospace forces perform four basic roles: (1) aerospace control, (2) force application, (3) force enhancement, and (4) force support. The role of force support includes all the things that must be accomplished before the missions in the other roles can be performed effectively. As a medical journeyman, your role falls under force support. You have a personal and moral responsibility to help ensure wartime readiness and effectiveness of the US Air Force by faithfully accomplishing your assigned tasks.

We, in this career field, help ensure wartime readiness and effectiveness by protecting the general health of AF members and their families. We do this through prevention or correction of medical problems. What do we mean by prevention or correction of medical problems? An example of preventive care is required annual dental examinations. Everyone in the Air Force is required to report to the base medical facility for annual dental examinations. This is an example of preventive care. Its purpose is to prevent illness. Corrective medical care, on the other hand, is given when you are provided with medical care for a personal illness or injury.

Organization

You need to know how your efforts fit into the total effort of your unit and where your unit fits into the big picture.

Surgeon General, USAF

The Surgeon General, USAF, is the head of the AF Medical Service and is the medical staff advisor to the Secretary of the Air Force and Chief of Staff, USAF.

Major command (MAJCOM) surgeon

The surgeon at each MAJCOM is responsible for implementing the Surgeon General's programs and policies. This person responds to and advises his or her MAJCOM commander on Medical Service matters.

Medical treatment facility (MTF) commander

The MTF commander is responsible for directing all medical programs on a base or wing, and is responsible to the base or wing commander.

Objective medical group (OMG) structure

Medical groups normally consist of four subordinate squadrons: (1) medical operations, (2) aerospace medicine, (3) dental, and (4) medical support (fig. 1–1). This structure includes all medical centers (except the 59th Medical Wing at Lackland AFB), hospitals, and large clinics with 100,000 or more outpatient visits annually.

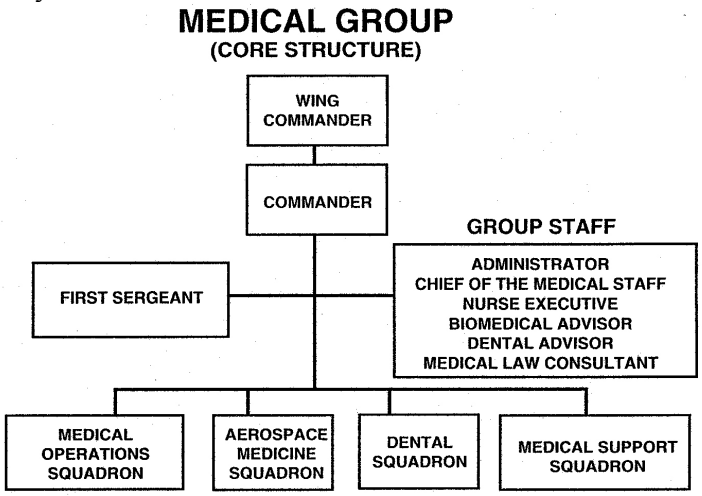


Figure 1–1. Objective medical group.

Smaller medical groups often contain only two subordinate squadrons: medical operations and medical support (fig. 1–2). Medical squadrons are small clinics. (See fig. 1–3 for their structure.) As bases resize, different organizational structures will emerge to meet the base's mission. These new structures may be hybrids of those mentioned earlier.

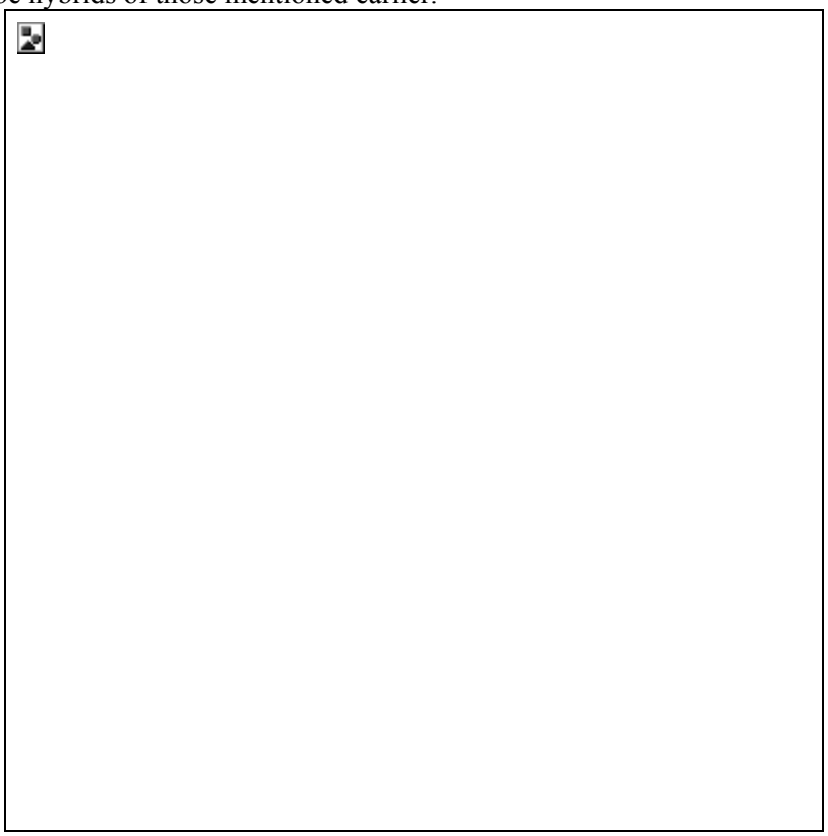


Figure 1–2. Medical group (with two squadrons).

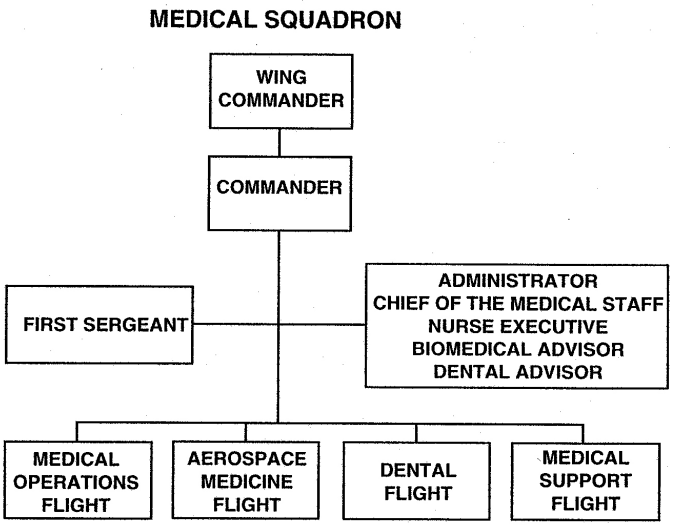


Figure 1–3. Medical squadron structure.

002. Aerospace Medical Service mission and organization

The Aerospace Medicine Program (AMP)varies from base to base according to such factors as population, geographical location, and mission. There are many areas of concern within the Aerospace Medicine Program. AFI 48-101, *Aerospace Medical Operations*, gives the areas of professional concern and the functions of each.

Mission

AFPD 48-1 states, "*The Aerospace Medical policy is aimed at identifying and preventing illness and injury and maintaining a healthy work environment*." This directive establishes policies for specialized aerospace medicine operations in several disciplines, which together form the AMP. This program is intended to sustain and improve the health and performance of personnel assigned to operations functions to prevent disease and injury in the work force and protect the environment.

Organization

The AF Surgeon General manages the Aerospace Medicine Program through the Aerospace Medicine Consultants Division of the Directorate of Professional Affairs and Quality Assurance, HQ USAF/SGP.

Aerospace medicine squadron structure

On most bases, there are five approved flights in the aerospace medicine squadron: flight/missile medicine, health promotion, public health, readiness, and bioenvironmental engineering (fig. 1–4). Additional separate functional flights are authorized at those locations possessing a physiological training flight (PTF) and/or aeromedical staging flight (ASF).

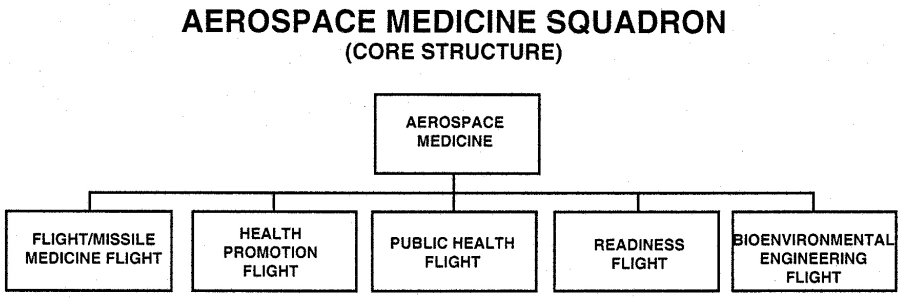


Figure 1–4. Aerospace medicine squadron (core structure).

Roles and responsibilities

The paragraphs below delineate the roles and responsibilities of each aerospace medicine squadron flight and two additional functional flights.

Flight/missile medicine flight

This flight provides:

- Clinical and preventive medicine input to all key elements in the squadron.
- Primary care to flying and special operational duty personnel.
- Periodic and occupational health evaluations and fitness for duty assessments.
- Optometry services to medical group beneficiaries.

Key elements in the flight/missile medicine flight include: flight/missile medicine, occupational medicine, physical examinations and standards, operational hyperbaric medicine, and optometry services.

Health promotion flight

The health promotion flight:

- Is responsible for the primary and secondary prevention efforts associated with life-style-related morbidity while supporting accessible, cost effective, and qualitative health delivery.
- It also manages health and wellness centers, which provide assessments, evaluations, programs, strategies for compressing morbidity and reducing mortality of the active duty and civil servant populations, and referrals for medical consultation.

Key elements in the health promotion flight include: health promotion and prevention awareness, education, motivation, and intervention, and health and wellness centers (matrixed with the wing).

Public health flight

This flight:

- Prevents disease, disability, morbidity, and death through effective use of population-based public health programs.
- Conducts epidemiological surveillance and analysis of communicable, environmental, and occupational morbidity and mortality to establish and prioritize strategies for prevention and intervention.
- Provides programs for both individuals and groups to clearly communicate risks and hazards in the workplace/environment and best practices to safeguard health.

Key elements in the public health flight include: epidemiological services, disease and injury prevention, food safety, immunizations, patient decontamination, medical intelligence.

Readiness flight

This flight:

- Is responsible for the medical readiness posture of the medical treatment facility.
- Ensures medical elements are organized, trained, and equipped to respond to any operational contingency.

Key elements in the readiness flight include Plans.

Bioenvironmental engineering flight

The bioenvironmental engineering flight:

- Uses a comprehensive approach to anticipate, recognize, evaluate, and control chemical, physical, radiological, and biological threats in all media (air/water/ground) from cradle to

grave. Through effective sampling, analysis, and monitoring, this flight ensures regulatory compliance in our industrial and community environments.

Key elements in the bioenvironmental engineering flight include environmental quality and industrial hygiene.

Additional functional flights

There are two additional functional flights you need to know about. Their roles and responsibilities are outlined below.

Aerospace physiology/physiological training flight

This flight:

- Supports local and regional DOD operational commanders by providing appropriate aerospace physiology and human performance enhancement training.
- Works as an integrated team with flight safety and aeromedical personnel in addressing required training needs.
- Provides consultant services upon request for flying safety activities and physiological/human factor investigations and analysis of military aircraft mishaps.
- Provides qualified personnel to participate in high altitude airdrop missions, as required.

Key elements in the physiological training flight include: administration, training, maintenance, and supply.

Aeromedical staging flight

This flight:

- Receives, shelters, processes.
- Provides medical and nursing care to patients who enter, travel in, or leave the aeromedical evacuation system.

Key elements in the aeromedical staging flight include: patient support (transportation, education, and training), patient care (quality assurance, risk management, infection control, and nursing), and administration (patient administration, biometrics, fiscal management, and logistics management).

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

001. USAF Medical Service mission and organization

1. What are the three medical command levels?

2. What are the responsibilities of the MTF commander? To whom is the MTF commander responsible?

3. Name the four subordinate squadrons in all medical centers, hospitals and large clinics with 100,000 or more outpatient visits annually.

002. Aerospace Medical Service mission and organization

1. Name the five flights of the aerospace medicine squadron.

2. The physical examinations and standards section belongs to which flight?

3. Which flight anticipates, recognizes, evaluates, and controls chemical, physical, radiological, and biological threats?

1–2. Public Health

You've looked at the objectives of the Aerospace Medicine Program and studied all of the functional areas. Now, take a closer look at Public Health and see how it fits into the big picture.

003. Public Health mission and organization

Objectives

Public Health (PH) is your area of responsibility. Following is a list of PH objectives from AFI 48-101:

1. Collects and reviews morbidity and mortality data to establish baselines, identify trends, and propose intervention strategies.
2. Directs epidemiological investigations and reporting of communicable disease outbreaks with appropriate actions IAW AFI 48-105, *Control of Communicable Diseases*, and AFI 48-109, *USAF Epidemiological Services*.
3. Maintains liaison with federal, state, and local public health authorities.
4. Conducts food safety programs and facility sanitation inspections IAW AFI 48-116, *Food Safety*, and AFI 48-117, *Public Facility Sanitation*.
5. Conducts the fetal protection program.
6. Collects, analyzes, and reports pediatric blood lead screening data. Conducts blood lead toxicity investigations. Assists community lead poisoning prevention education programs.
7. Conducts the tuberculosis control program IAW AFI 48-115, *TB Detection and Control*, the sexually transmitted disease program IAW AFI 48-106, *Prevention and Control of Sexually Transmitted Disease*, and AFI 48-135, *Immunodeficiency Virus Program*.
8. Identifies the sources and prevalence of pests impacting Air Force health and efficiency IAW AFI 48-102, *Medical Entomology Program*.
9. Develops, in collaboration with the infection control committee, admission and quarantine policies to prevent the spread of disease from contagious patients to the community, the medical staff, and other patients.
10. Establishes appropriate disease vector surveillance.
11. Supports public education programs on environmental quality and safety.
12. Provides operational support as the medical intelligence officer for deploying personnel by incorporating disease prevention strategies.
13. Provides public health briefings and debriefings for deployment locations.
14. Provides water sanitation/safety surveillance and consultation services.

15. Develops and exercises patient decontamination capabilities.

These objectives are accomplished by performing tasks in the areas of preventive medicine, communicable disease control, epidemiology, medical entomology, occupational health, food safety, and PH readiness.

Preventive medicine program

This program evaluates hygiene practices and the usability of equipment in base facilities according to AFI 48-105, AFI 48-117, AFI 34-248, *Child Development Centers*, and AFI 34-276, *Family Child Care Programs*. Report findings and recommend corrective action through the MTF commander to the responsible agencies. The program also offers support to all base preventive medicine programs.

Communicable disease control

General procedures for controlling communicable diseases are contained in AFI 48-105, and in the *Control of Communicable Diseases Manual*, an official report of the American Public Health Association.

Methods of communicable disease control include immunizations and testing for various communicable diseases. Immunization and testing procedures are generally performed by the medical unit's immunization element or laboratory. However, PH closely monitors tuberculosis skin testing to be sure the procedures in AFI 48-115, are understood and followed to encourage consultation when there is doubt about the medical or administrative disposition of a case and make sure revisions and special requirements in the testing program are received and acted upon.

Epidemiology

Epidemiology is the study of how disease and injury occur in a population. Epidemiology evaluates the distribution and dynamics of health and disease. This information helps us understand the causes of disease and injury and how best to prevent them. The epidemiologic functions performed by Public Health include maintaining biostatistics relating to disease and injury incidence, prevalence, morbidity, mortality, and military noneffectiveness. Significant epidemiological trends are reported to all health care providers through the chief, Aeromedical Services.

Medical entomology

The two areas in medical entomology that PH is concerned with—pest management and quarantine activities.

PH determines the identity, source, and prevalence of pests affecting AF health and efficiency. We advise commanders on the incidence of disease vectors, control measures, and health education requirements and on selecting recreation sites when disease vectors are of concern.

The PH quarantine program conforms to the policies set in regulations issued by the US Departments of Agriculture, Health and Human Services, Treasury, Interior, and Commerce.

PH supports the program's goals of preventing the introduction and dissemination of diseases of humans, plants, and animals; of prohibited wildlife or arthropod vectors; and of pests of health and agricultural significance by movement of Armed Forces conveyance internationally and in the continental United States (CONUS).

PH also directly supports formal retrograde materiel preclearance activities contained in AFI 48-104, *Quarantine Regulations of the Armed Forces*. This applies to military cargo returning to the United States.

Occupational health program

The Air Force meets its obligation to promote good employee health through the occupational health program, which is consistent with the Occupational Safety and Health Act of 1970 (29 U.S.C. 668(a)). Medical services provided to FEDERAL civilian employees are authorized by Public Law

70-568 (5 U.S.C. 7901). All occupational health medical examinations must be conducted in accordance with AFI 48-145, *Occupational Health Program*, and DoD 6055.5-M, *Occupational Medical Surveillance Manual*. PH provides epidemiologic surveillance in the occupational setting, provides risk communication consultation as needed, and ensures the administrative aspects of the program are conducted correctly and efficiently. PH also provides supervisor and worker education, fits some personal protective equipment such as ear plugs, and performs shop visits.

Food safety/environmental surveys

The Public Health officer monitors the medical aspects of the food safety program. The program includes the following:

Responsibility	Explanation
Food inspection	Inspects food to determine wholesomeness, condition, and quality. We advise the accountable officer of proper action to dispose of contaminated, deteriorated, or otherwise nonconforming food items.
Food sanitation	Evaluates establishments and facilities where food is produced, prepared, stored, or otherwise handled. Corrective actions are recommended when unsanitary practices or improper methods are found in accordance with the FDA Food Code, or AFI 48-116.

Public Health readiness

Public Health supports deployable forces through reduction of disease non-battle injuries (DNBI) and medical decontamination. We reduce DNBI using the disease surveillance program. The disease surveillance program tracks the health of deployed troops prior during and after they return from a deployment. Other methods to reduce DNBI are medical intelligence briefings, field hygiene and sanitation program, field food and water safety, and field occupational health programs. AFI 41-106, provides guidance for Public Health plans and responsibilities of the medical intelligence officer.

Medical Decontamination provides a barrier between the nuclear, biological, or chemical environment and the MTF in a wartime environment. Public Health is tasked to lead, man, and train the wartime patient decontamination team. The AF medical service concept of operations for the wartime patient decontamination team provides operational capabilities and guidelines for the decontamination process.

Self-inspections

Public Health consists of a wide variety of duties and responsibilities. A self-inspection is a means by which you can evaluate your work to see if you are performing to established standards. Your office has checklists to use to conduct your inspection for each area of responsibility within Public Health.

Self-inspections are done to determine if you are performing to standards, but more importantly, to ensure you are meeting the needs of your customer. If deficiencies are noted, don't just ignore them and hope they go away. Plan and implement corrective measures to correct the problem. Once changes are made, it's equally as important to monitor your corrective measures to ensure they are working properly. As you can see, if done properly, self-inspections are done on a continual basis.

Aerospace medicine council

This forum allows for a continual review of the activities within Aerospace Medicine and provides a system to identify and correct potential problem areas within Aerospace Medicine. This council is composed of the chief, Aerospace Medicine (chairperson); chief, Clinic or Hospital Services; and the officer-in-charge (OIC) and noncommissioned-officer-in-charge (NCOIC) of each functional area within Aerospace Medicine Services.

In other words, the aerospace medicine council connects all of the functions within the Aerospace Medicine Program. It coordinates and standardizes your activities as well as the activities of all other

personnel within the program so that effort is not wasted, misdirected, or ignored. It's your responsibility to provide input to your supervisor regarding your programs.

004. Federal agencies that provide assistance to Public Health

Before leaving unit 1, you need to learn about some of the agencies you may deal with as a Public Health journeyman. Though the PH journeyman is trained to handle any problem that may arise, you may need some assistance from agencies outside of the Air Force in order to do your job.

Federal public health agencies

The federal government sets health standards for most aspects of our lives. It also surveys and makes recommendations on the general public health, its status, and areas needing improvement. Various agencies are assigned these tasks. You'll learn some of those agencies you'll come into contact with as a member of Public Health.

United States Department of Health and Human Services (USDHHS)

The USDHHS is comprised of several agencies concerned with public health. These are shown in the following table:

Agency	Explanation
Food and Drug Administration (FDA)	Is a major portion of the USDHHS. Within the FDA, the Bureau of Foods designs and enforces programs that guarantee the quality and safety of foods. It also enforces laws and regulations relating to food service operations and shares the responsibility with the US Department of Agriculture (USDA) for inspecting food processing plants.
US Public Health Service (USPHS)	Is also part of the USDHHS. This agency produces regulations and guidance in the area of national public health and training and education in such areas as nutrition, hygiene, and disease prevention.
Centers for Disease Control (CDC)	Located in Atlanta, Georgia, is a field agency of the USPHS. The center investigates outbreaks of foodborne illness, studies the causes and control of diseases, publishes statistical data such as the *Morbidity and Mortality Weekly Report*, and provides educational services in sanitation; epidemiology; vectorborne, waterborne, and foodborne disease control; and food microbiology.
Environmental Protection Agency (EPA)	Is responsible for designing and enforcing programs that guarantee the continued safety and purity of our environment. The air and water and the active prevention of their pollution are the domain of the EPA. Regulations written by the EPA are used by the Air Force to protect the base environment.

Federal food inspection agencies

The food inspection program provided by Public Health involves a great deal of interaction between local, state, and Federal inspection agencies and your food inspection office. Many of the publications used to inspect foods on military installations are written and used by these agencies in civilian inspection programs.

Agency	Explanation
US Department Of Agriculture (USDA)	Responsible for inspecting and grading meat, meat products, poultry, dairy products, eggs and egg products, and fruits and vegetables shipped across state boundaries. As mentioned earlier, some of its inspection responsibilities overlap with those of the FDA. Virtually every food found on your grocery shelf has received some form of inspection during production, processing, and shipment.
US Department of Commerce (USDC)	Through its National Marine Fisheries Service, provides a program of voluntary inspection of seafoods and seafood processing plants as well as the waters from which they are harvested. They also provide grading of seafoods on a voluntary basis.

Federal occupational safety and health agencies

Again, Public Health interacts in many areas with occupational safety and health agencies—for guidance, regulatory clarification, assistance, and training. Two of the most commonly used agencies are the Occupational Safety and Health Administration (OSHA) and the National Institute of Occupational Safety and Health (NIOSH).

Agency	*Explanation*
OSHA	Is an agency within the US Department of Labor. This agency, or administration, provides the regulations, guidance, and enforcement necessary to meet the requirements of the Occupational Safety and Health Act of 1970. The act ensures every man and woman in the United States a safe and healthful workplace. Training workers to be more aware of job safety and health hazards helps reduce the incidence of occupational injury and disease. As a Public Health Journeyman, you'll be involved in this kind of training. OSHA standards are used to evaluate AF workplaces and train AF civilian and military workers.
NIOSH	Is a part of the CDC, a subagency of the USDHHS. NIOSH provides training and publications in the area of safety and health in the workplace. NIOSH standards are used by the Air Force when evaluating working environments at base level industrial sites. A discussion of agencies within the federal government that might provide assistance to the AF Public Health could become endless; but now you know you are not alone with these important responsibilities. Whenever you need to seek aid from an agency outside the military, look in the Federal Government Registry or in any telephone book for help.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

003. Public Health mission and organization

1. What is the study of how disease and injury occur in a population?

2. To whom are significant epidemiological trends reported?

3. What are the two areas PH is concerned with in the medical entomology program?

4. What duties does PH perform under the Occupational Health Program?

5. What two areas is PH responsible for under food safety/environmental surveys?

6. Who are the members of an aerospace medicine council?

004. Federal agencies that provide assistance to Public Health

1. The Food and Drug Administration (FDA) falls under what agency?

2. Which agency investigates foodborne illness and studies the causes and control of disease?

3. What are the responsibilities of the USDA?

4. What does the Air Force use from NIOSH?

5. Where can you look for agencies outside the military?

Answers to Self-Test Questions

001

1. Surgeon General, USAF; MAJCOM surgeon; and MTF commander.
2. For directing all medical programs on a base or wing; to the base or wing commander.
3. (1) Medical operations, (2) aerospace medicine, (3) dental, and (4) medical support.

002

1. (1) Flight/missile medicine flight, (2) health promotion flight, (3) public health flight, (4) readiness flight, and (5) bioenvironmental engineering flight.
2. Flight/missile medicine flight.
3. Bioenvironmental engineering flight.

003

1. Epidemiology.
2. To all health care providers through the Chief, Aeromedical Services.
3. Pest management and quarantine activities.
4. Ensures the administrative aspects of the program are conducted correctly and efficiently, provides worker education, fits personal protective equipment, and performs shop visits.
5. Food inspection and food sanitation.
6. Chief, Aerospace Medicine; chief, Clinic or Hospital Services; and OIC/NCOIC of each functional area within aerospace medicine services.

004

1. US Department of Health and Human Services (USDHHS).
2. Centers for Disease Control (CDC).
3. Inspect and grade meat, meat products, poultry, dairy products, eggs and egg products, and fruits and vegetables shipped across state boundaries.
4. NIOSH standards when evaluating working environments at base-level industrial sites.
5. Federal Government Registry or any telephone book.

Do the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to ECI Form 34, Field Scoring Answer Sheet.

Do not return your answer sheet to AFIADL.

1. (001) The medical advisor to the Secretary of the Air Force and the Chief of Staff is the
   a. Surgeon General, USAF.
   b. MAJCOM Surgeon General.
   c. Commander, Veterans Administration.
   d. Director of Base Medical Services (DBMS).

2. (001) The Director of Base Medical Services (DBMS) is responsible for
   a. directing the USAF Medical Service.
   b. advising the MAJCOM commander on medical matters.
   c. implementing MAJCOM medical policies throughout a MAJCOM.
   d. directing all medical programs on a base or within a wing-level organization.

3. (002) The approved flights within the aerospace medicine squadron on most bases are flight/missile medicine, public health, bioenvironmental engineering,
   a. health promotion, readiness, and aeromedical staging.
   b. health promotion, and physiological training.
   c. health promotion, and readiness.
   d. and readiness.

4. (002) The two key elements of a bioenvironmental engineering flight are
   a. health promotion and industrial hygiene.
   b. environmental quality and industrial hygiene.
   c. disease and injury prevention, and industrial hygiene.
   d. disease and injury prevention, and environmental quality.

5. (003) The study of how disease and injury occur in a population is known as
   a. entomology.
   b. epidemiology.
   c. parisitology.
   d. microbiology.

6. (003) Significant epidemiological trends are reported to all health care providers through the
   a. medical group commander.
   b. chief, Aeromedical Services.
   c. Public Health officer (PHO).
   d. base epidemiologist.

7. (003) Worker education, fitting personal protection equipment such as ear plugs, and ensuring the proper administration of the AF Occupational Health Program are responsibilities of
   a. Public Health.
   b. the local Public Health Service.
   c. Centers for Disease Control.
   d. the National Institute for Occupational Safety and Health (NIOSH).

8. (003) Who monitors the medical aspects of the food safety program?
   a. Medical group commander.
   b. Base commander/wing commander.
   c. Public Health officer (PHO).
   d. Food facility managers.

9. (003) Which forum allows for a continual review of the activities within Aerospace Medicine?
   a. Occupational health working group.
   b. Aerospace medicine council.
   c. Base safety council.
   d. Executive council.

10. (004) Which agency designs and enforces programs that guarantee the quality and safety of foods?
   a. US Department of Food Purity.
   b. US Public Health Service.
   c. US Department of Commerce.
   d. US Food and Drug Administration.

11. (004) Which agency publishes statistical data such as the Morbidity and Mortality Weekly Report?
   a. Centers for Disease Control (CDC).
   b. Environmental Protection Agency (EPA).
   c. Department of Agriculture (USDA).
   d. Occupational Safety and Health Administration (OSHA).

Please read the unit menu for unit 2 and continue ➔

Student Notes

Unit 2. Biology

Biology is the study of living organisms and life processes. In this unit you'll learn general biology principles necessary for understanding how the body functions in health and disease. You'll begin with a section on the structure and function of the human cell.

2–1. The Human Cell

From a single cell, called a fertilized ovum, a human organism develops. The basic sequence of growth is, simply stated, cells combine to form tissues, similar tissues join to form organs, and the related tissues and organs become the various systems of a living organism. The cell is the smallest unit capable of performing life functions; therefore, you'll begin studying at the lowest level of the organism.

005. The cell

A cell is the microscopic unit of structure of all living things. An entire organism consists of either a single cell (unicellular) or many cells (multicellular).

Plant cells

All living matter is composed of cells; however, animal cells and plant cells significantly differ from one another. Plant cells contain chlorophyll, a green pigment that mixes with sunlight and water to form energy for plants. Plant cells also have a cell wall around them made up of a very complex carbohydrate known as cellulose. Neither chlorophyll nor a cell wall is present in animal cells.

Animal cells

A typical animal cell includes a cell membrane, a nucleus, protoplasm, organelles, endoplasmic reticulum, ribosomes, vacuoles, Golgi complex, mitochondria, centrioles, and lysosomes.

Components

A typical animal cell is shown in figure 2–1. Refer to this figure to follow along with the explanations of the cell membrane, nucleus, protoplasm, and organelles.

Cell membrane

The cell membrane surrounds and separates the cell from its environment. It selectively allows certain materials to pass through as they enter or leave the cell; all substances must pass through this membrane. The cell membrane is also called the plasma membrane.

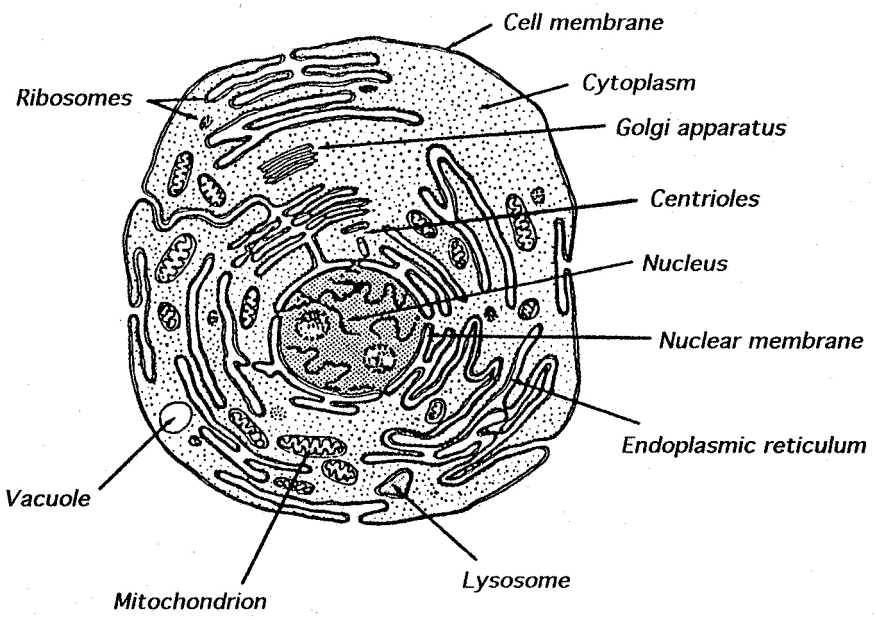


Figure 2–1. Typical animal cell.

Nucleus

The nucleus lies within the cell, and a nuclear membrane separates it from the cytoplasm. The nucleus stores information that guides the life processes of the cell. This information is stored in a chemical form called chromatin material, which is made of the protein deoxyribonucleic acid (DNA). At the time of cell division, the chromatin material collects into individual structures known as chromosomes. Chromosomes can only be seen clearly during cell division. They are composed of both nucleic acid and protein. Each chromosome has a set of specific genes that determine all of the physical and chemical characteristics of the body. Genes are the basic units of heredity, which pass from parents to their children. Genes guide the activities of each individual cell.

Protoplasm

The major substance of the cell is protoplasm. It's a combination of water and a variety of materials dissolved in the water. Inside the cell nucleus, protoplasm is called nucleoplasm; outside the cell nucleus, it's called cytoplasm.

Organelles

Within the cytoplasm are certain structures called organelles. These organelles include structures such as the endoplasmic reticulum, Golgi complex, ribosomes, vacuoles, mitochondria, centrioles, and lysosomes.

Structure	Explanation
Endoplasmic reticulum	Resembles a circulatory system for the individual cell. It's a network composed of unit (single-thickness) membranes. In many cells, it connects the nucleus with the outside of the cell.
Golgi complex	The "traffic director" for cellular proteins, receives certain protein substances from the endoplasmic reticulum. It aids in the final preparation of these proteins and mucus-like substances and in the movement of these substances.
Ribosomes	Are granular particle "protein factories" in the cell. They contain ribonucleic acid (RNA). Ribosomes are found free in the cytoplasm, clustered, or attached to the endoplasmic reticulum.

Structure	Explanation
Mitochondria	Are the “powerhouses” of the cell. They recharge adenosine diphosphate (ADP) molecules to form adenosine triphosphate (ATP) molecules, the chemical energy of the body.
Centrioles	There are ordinarily two centrioles. These organelles play a major role in cell division.
Lysosomes	Are membrane-bound spheres that contain enzymes that can digest intracellular structures or foreign substances, such as bacteria.

006. Cell growth and multiplication (mitosis)

Individual cells have the capacity to grow and multiply. This lesson explains how the cells grow and multiply through mitosis.

Cell growth

Individual cells have the capacity to grow. They do this by acquiring various substances from the blood and converting them into appropriate cellular elements.

Individual cells have specific life spans. Some types of cells have longer life spans than others. For example, the average life span of a red blood cell is 100 to 120 days, whereas the life span of a white blood cell varies from 100 to 300 days, depending on the body’s need. During the growth and repair process, new cells are formed.

Cell multiplication

Cell multiplication is accomplished through a process called mitosis. In mitosis, the genetic material of the cell is doubled, divided equally inside the parent cell, forming two daughter cells. The two new daughter cells each have the same genetic composition as the original cell.

Hypertrophy/hyperplasia

Hypertrophy and hyperplasia are two ways in which the body’s cell mass increases. With hypertrophy, there is an increase in the size of the individual cell. No new cells are formed. An example of hypertrophy is muscle enlargement. The diameter of individual muscle fibers enlarges due to exercise .

On the other hand, increased tissue mass also can result from greater numbers of cells. This is called hyperplasia. An example of abnormal hyperplasia is cancer.

Atrophy

Atrophy is the loss of cellular mass or a wasting away of the cell. For example, if a muscle cell does not receive impulses to contract for an extended period of time, the cell will shrink in size and eventually be replaced with fibrous tissue. Such a change can be irreversible, depending on the cause.

Energy

The human body depends on external sources for energy. Plants use solar radiation to make glucose and other nutrients. The human body takes glucose and other nutrients directly or indirectly from plants and animal tissues and receives oxygen from the air. The energy within the plant and animal tissue is released within human cells by the process of metabolic oxidation. This involves the combination of glucose and other nutrients with oxygen, thus releasing the stored energy.

The mitochondria of the cells use this released energy to form ATP) molecules from ADP molecules. ADP is converted to ATP by the addition of a part of a molecule called a phosphate radical. The binding of the phosphate radical requires a large quantity of energy,

which can be released later when the phosphate radical is lost. ATP provides energy for cellular processes such as active transport of substances across cell membranes, synthesis of chemical compounds for the body, and mechanical work such as muscle contraction. When an ATP molecule provides energy for such a process, it loses a phosphate radical and becomes ADP. Then, the cycle begins again as ADP is converted into ATP within the mitochondria.

Certain cells, such as muscle cells and nerve cells, require great amounts of energy. These cells have well-developed mitochondria.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

005. The cell

1. What is the microscopic unit of structure of all living things?

2. What is the green pigment that plant cells contain but not animal cells?

3. What is the name of the cell component that surrounds the cell and allows certain materials to pass through it?

4. What are the basic units of heredity that guide the activities of each individual cell?

5. Which organelles are the "powerhouses" of the cell that recharge ADP to form ATP molecules?

006. Cell growth and multiplication (mitosis)

1. What is the name of the process in which the genetic material of the cell is doubled?

2. What is the name of the condition when size of the individual cells increases?

3. What do we call increased tissue mass that results from greater numbers of cells?

4. What is the loss of tissue mass that results from a wasting away of the cell?

2–2. Human Fluids and Tissues

This section covers fluid compartments and continues with the unique role of water and dissolved substances. You'll complete this section by learning the tissue fluid cycle and how the body maintains its water and electrolyte balances.

Approximately 56 percent of the human body consists of fluids. Some tissues consist almost completely of fluids. About two-thirds of the fluid is located in the cells with the remainder of the fluid located on the outside of the cells. These body fluids are composed largely of water; thus, water is the major component of living substances. The body strives to be in fluid balance or contain the required amount of water distributed to the various compartments according to their needs.

007. Body fluids

Fluid compartments

The human body contains fluid compartments or spaces that contain the intracellular and extracellular fluids.

Fluid	Explanation
Intracellular	Water is the major constituent within the cell. This fluid is called intracellular or within the cell fluid.
Extracellular	All other fluids are extracellular. The extracellular fluids are found in two different compartments. Interstitial (also called intercellular) fluid is tissue fluid located between the cells of the body. In some systems, fluids serve as a vehicle to carry items around the body. These systems are called circulatory systems. The circulating fluid is called the plasma—the noncellular component of blood.

Water

As You learned previously, water is the main constituent of the human body. It's often called the universal solvent. This refers to its ability to dissolve so many substances within itself. Thus, water is an excellent vehicle for the circulatory systems. Water is very useful in the body's temperature control mechanisms. This is due to its heat-carrying capacity and tendency to remove large numbers of calories during evaporation.

Sources

Thirst and satisfaction are controlled by special centers in the hypothalamus of the brain. The human body obtains water in two primary ways:

Ways Body Gets Water	Explanation
Drinking	Most items humans drink or eat consist largely of water.
Metabolic oxidation	A second source of water is metabolic oxidation. As various food substances are oxidized within the individual cell, water is one of the main byproducts. This water is referred to as metabolic water.

Losses

The ways the human body can lose water are through perspiration, respiration, urination, and vomiting and diarrhea as explained in this table.

Ways Body Gets Rid of Water	Explanation
Perspiration	Water is continuously lost from the body in the form of perspiration or sweat. With high surrounding temperatures and vigorous exercise, the sweat is obvious. This is called sensible perspiration. Even when sweat is not obvious, there is a low

	level of water loss. This is called insensible perspiration.
Respiration	The surfaces of the lungs must be moist to ensure the passage of gases to and from the blood. Air is moistened within the respiratory passages and the alveoli of the lungs. Thus, moisture passes out of the body along with the exhaled breath.
Urination	Water is also lost from the body in the form of urine. Urine carries nitrogenous wastes of protein metabolism dissolved in water.
Vomiting and diarrhea	During vomiting and diarrhea, the body loses large quantities of water and dissolved electrolytes. In infants and the elderly, this loss of water and electrolytes can be very dangerous. Death may result.

Dissolved substances

As mentioned before, one of the characteristics of water that makes it so desirable is its capacity to dissolve almost anything, as explained here:

What is Dissolved	Explanation
Gases	Oxygen and carbon dioxide are exchanged between the air in the lungs and the blood. They are also exchanged between the blood and the individual cells of the body. In part, these gases are carried as dissolved substances in the water of the blood.
Nutrients	Nutrients are the end products of digestion and vitamins and minerals absorbed from the digestive system. They are dissolved in the water portion of the blood and distributed to the individual cells of the body.
Wastes	Wastes result from the metabolic processes of the body. Wastes are picked up from the individual cells and delivered dissolved in the water to the excretory organs of the body, such as the kidneys.
Hormones	Hormones, while dissolved in the water of the blood, are carried from the endocrine glands to specific target organs.

Tissue fluid cycle

The extracellular fluid found between the cells is called the tissue fluid or interstitial fluid. Tissue fluid originates primarily from the fluid portion of the blood, some of which escapes into the tissue from the capillaries. Part of this escaped fluid enters the beginning of the venous vessels. However, a large percentage of the tissue fluid is picked up by another circulatory system, the lymphatic system. Thus, there is a continuous flow of fluids throughout the body. In addition, the intracellular fluid and the immediate extracellular fluid are continually being exchanged.

Homeostasis

Homeostasis is the body's tendency to maintain a steady state of balance. Body fluids play an important role in homeostasis. The tissue fluids form the immediate environment of the living cell. Appropriate concentrations of oxygen, carbon dioxide, nutrients, electrolytes, and other substances must be present in the tissue fluid to maintain the life processes of the individual cells.

One of the chief functions of any organ system is to help maintain this steady state. For example, the digestive system helps to maintain a steady concentration of nutrients. The respiratory system helps maintain steady concentrations of oxygen and the removal of carbon dioxide.

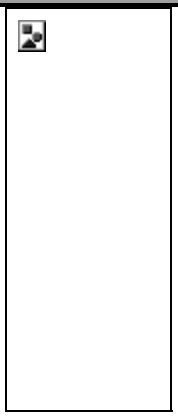
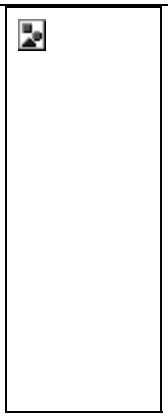
All organ systems are partially controlled by a feedback mechanism that resembles a household thermostat. When the concentration of a substance is too low, the feedback mechanism stimulates increased production and distribution of that substance. Once the level returns to normal, the feedback mechanism signals a decrease in production. There is a similar feedback mechanism for body temperature.

Water balance

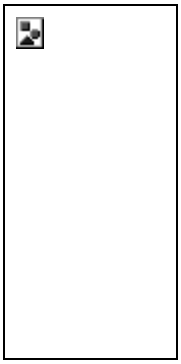
The body has a natural requirement for certain amounts of water to function properly. Lack of fluid in the circulatory system can result in heart failure. Excess fluid in the tissue spaces can result in swelling or edema of the body. There are feedback mechanisms to maintain water balance.

Electrolyte balance

There are certain chemicals within the body fluids known as electrolytes. Electrolytes are chemicals that dissociate (break up) into ions (charged particles) when they are dissolved. To maintain life and good health, electrolytes must be in balance. That is, they must be present in certain proportions and concentrations in each fluid compartment.

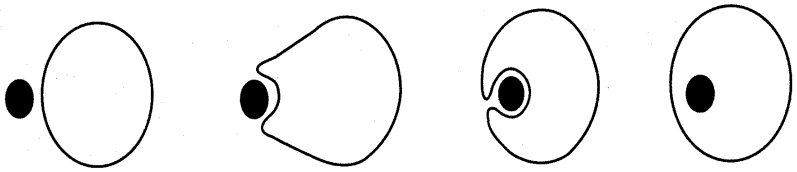
Condition	Explanation	Illustration
Hypertonicity	If the overall electrolyte concentration is greater in extracellular fluid than in intracellular fluid, the fluid is hypertonic (fig. 2–2a). The cell may be destroyed because it loses its fluid to the hypertonic environment.	 **Figure 2–2a. Tonicity (++Electrolytes) (→ direction of water flow or osmosis).**
Hypotonicity	If the overall electrolyte concentration is lesser in extracellular fluid than in intracellular fluid, the fluid is hypotonic (fig. 2–2b). In a hypotonic intracellular environment, fluid will enter the cell and cause it to swell and possibly burst.	 **Figure 2–2b. Tonicity (++Electrolytes) (→ direction of water flow or osmosis).**

Condition	Explanation	Illustration

Isotonicity	If the electrolyte concentrations of extracellular fluid equals that of intracellular fluid, the situation is balanced (homeostatic). That is, the fluids are isotonic (fig. 2–2c).	 **Figure 2–2c. Tonicity (++Electrolytes) (→ direction of water flow or osmosis).**

Movement in and out of the cell

You learned earlier that all substances entering or leaving the cell must pass through the cell membrane.

Process	Explanation
Semipermeability	The permeability of a membrane is its capacity to allow materials to move through it. Since the cell membrane of animal cells is selective and does not allow all materials to pass through it, we say that it is semipermeable.
Diffusion	The process of diffusion is when some materials readily pass through the cell membrane from an area of higher concentration to an area of lower concentration.
Osmosis	Sometimes a substance is not able to pass through the cell membrane. When the concentration of this substance is greater on one side of the cell membrane than the other, water will tend to pass through the membrane to the area of greater concentration. This process is called osmosis. This process involves the concept of tonicity, discussed earlier.
Pinocytosis and phagocytosis	Sometimes, the cell membrane will engulf a minute amount of tissue fluid and its contents. This process is called pinocytosis. During pinocytosis, the cell membrane produces a vacuole to contain the engulfed material. When the cell membrane engulfs larger particles, such as bacteria or other cells, the process is called phagocytosis (fig. 2–3). After either pinocytosis or phagocytosis, digestive fluids may pass from the cytoplasm into the vacuole. The end products of digestion are absorbed from the vacuole into the cell cytoplasm. PHAGOCYTOSIS. The cell gradually engulfs the solid particle such as a bacterial cell. If a water droplet is engulfed, the process is called "pinocytosis."  Phagocytic cell **Figure 2–3. Phagocytosis.**

Membrane potentials

In living cells there is generally a higher concentration of positively charged ions on the outside of the cell and a higher concentration of negatively charged ions on the inside of the cell. Thus, there is a concentration gradient (an electrical potential or polarity) across the membrane (called the membrane potential), which creates an electrical gradient.

Resting potential

In neurons, there are fewer positive ions inside the neuron than there are in the tissue fluid that surrounds it. This charge difference or electrical gradient is maintained by the Sodium (Na+)-Potassium (K+) Pump. This pump continually transports three positive sodium ions to the outside of the cell membrane and two positive potassium ions to the inside of the cell (3 + ions traded for 2 + ions gives a "more negative" overall charge on the inside of the neuron). As long as the inside of the cell stays more negative and the outside of the cell stays more positive, the neuron remains inactive or in a resting state.

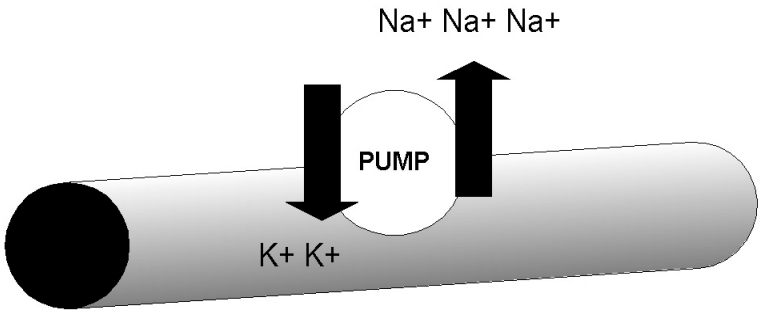


Figure 2–4a. The Na+ - K+ Pump maintaining the resting potential.

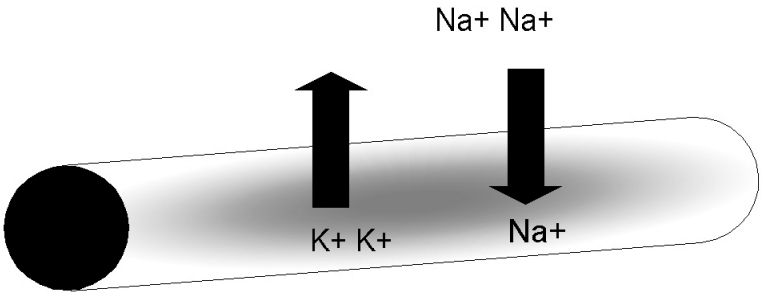


Figure 2–4b. The neuron depolarizes, the membranes becomes permeable or "more open" to ions, Na+ ions rush into the cell. Now the inside is more positive than the outside. If strong enough, an action potential is initiated.

Action potential

The electrical activity that occurs in stimulated neuron or muscle fiber and involves depolarization and subsequent repolarization is called the action potential (figs. 2–4a and 2–4b). First, sodium ions move into the cell by diffusion. This reverses the polarity (depolarization). Second, potassium moves out of the cell by diffusion, which causes repolarization. The sodium/potassium pump then restores the ionic balance by actively (energy required) pumping sodium back out and potassium back into the cell. These various electrical potentials can be measured with appropriate instruments.

008. Tissues and organs

In human beings and other multicellular organisms, the cells tend to be organized in specific ways. Cells grouped together to perform a common function or functions are called tissues.

Tissues that are grouped together to perform a common function are called organs. Examples of organs are the lungs and the heart. When organs are grouped together to perform a specific function, they are part of an organ system. An example of an organ system is the digestive system.

It's important to point out that, in some cases, a term can be used to describe both a type of tissue and a kind of organ. For example, we speak of bone tissue and of bones. We speak of muscle tissue and of muscles.

There are several major types of tissues. The most common types are epithelial, connective, muscle, and nervous tissues.

Epithelial tissue

Epithelial tissue is tissue that covers surfaces, lines cavities, and forms glands. It may protect, absorb, or secrete. It covers the outer surface of the body and lines the intestines, heart, blood vessels, lungs, and other hollow organs.

Connective tissue (CT)

Tissues that support body parts in various ways are known as connective tissues. The general function of these tissues is to protect, support, and bind together various organs.

The extracellular material or matrix surrounding the connective tissues characterizes the type of connective tissue. This matrix consists of fluid, semifluid, or mucus-like material and is produced by the connective tissue cells. The matrix is loose in mucous membranes and very rigid in bone. The spacing of this matrix is either loose or dense.

Loose connective tissue

In some locations, there are more cells with fewer fibers loosely arranged around them. This tissue is known as loose connective tissue or areolar tissue and serves as filler material in the spaces between the organs. This tissue is also found between the skin and the underlying structures of the body. Thus, the skin is able to move more or less freely over the surface of underlying structures. The fibers in the matrix are either collagenous, elastic, or reticular.

Dense connective tissue

The fibers of dense connective tissue are closely packed and more or less parallel. As membranes, dense connective tissue envelopes areas or structures of the body (as in capsules around organs such as the kidneys, heart, liver and lymph nodes). Other examples of dense connective tissue are ligaments and tendons. A ligament is a band of dense connective tissue that holds the bones together at a joint. A tendon attaches a muscle to a bone.

The elasticity of a connective tissue is more or less proportional to temperature. The cooler it is, the less elastic and more subject to damage. On the other hand, as the fiber becomes warmer, it becomes more elastic and resistant to damage. Elasticity is the basis of warmup exercises before participating in strenuous activities such as sports. By exercising to the point of sensible perspiration, the body temperature is raised. At this point, the connective tissues are able to stretch and withstand the various forces applied to them.

Adipose tissue

Another supportive tissue of the body is adipose tissue (fat connective tissue). Here, the matrix is a lipid material found within the cell rather than outside the cell. This is a form of loose connective tissue.

Lipids

Lipids are fats, oils, and similar compounds such as fatty acids. Lipids are stored mostly in the form of neutral fat. Neutral fats consist of triglycerides, a molecule formed from glycerol (a type of alcohol), and three fatty acids. The length of each fatty acid determines if the triglyceride is a liquid (oil) or a solid (fat). Triglycerides are kept in a liquid form, even in cold weather their lengths are adjusted in order to maintain a liquid state.

Sources

The diet is the major source of fat in the human body. Fats are taken in as fats or converted from other substances such as carbohydrates. Fats are essentially a temporary storage phenomenon. When metabolized, they yield large amounts of energy, especially when compared to carbohydrates.

Obesity

Obesity occurs when excess amounts of fats or carbohydrates are taken into the body. When the energy in these compounds is not used in body activities, the surplus is generally stored as triglycerides in fatty tissues.

Storage of fat-soluble substances

A number of fat-soluble substances are stored in fat, such as vitamins A and D. Also, organophosphate compounds of modern pesticides are often stored in human fat. They are ingested along with pesticide-treated foods or absorbed through the skin of employees who work with these compounds. The storage of these substances becomes particularly important if an individual loses significant body weight. As fat is lost during weight loss, these fat-soluble substances are released into the general system and can reach dangerous levels.

Cholesterol

Cholesterol is a lipoprotein. It's very important for the proper functioning of several structures and processes of the body, particularly the liver. However, there are some indications that excess cholesterol could damage the cardiovascular system.

Bone cartilage and blood are additional types of connective tissue that will be covered further in unit 3.

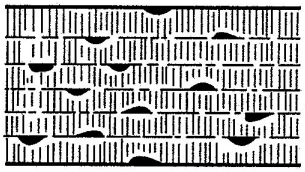
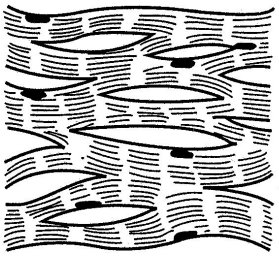
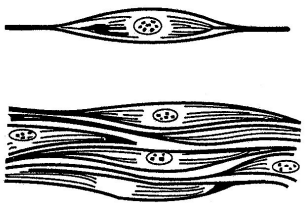
Fibers	Explanation
Collagenous	Main component also of dense connective tissue found in mucous membranes and nerves; they are tough and resistant, but flexible to a pulling force. They occur in bundles and are composed of tiny fibrils lying parallel to each other.
Elastic	These elastic fibers are smaller than collagenous fibers and provide strength and stretching ability. They are found in the walls in arteries, lung tissue, and bronchial tubes. They can stretch up to 50 percent of their length.
Reticular	Are very thin, provide support and strength, and form the framework for many soft organs.

Muscle tissues

Muscles are made of muscle tissues. Muscle tissues and the muscles they make up are specialized to contract and to stretch. They are able to produce motion because of their ability to contract.

Types of muscle tissues

There are three types of muscle tissues. These muscles are categorized by their location and structure.

Type of MuscleTissue	Explanation	Illustration
Skeletal	The cells or muscle fibers of skeletal muscle tissue are long and cylindrical and have numerous nuclei. The arrangement of the cellular contents is very specific and results in a striated or band-like structured appearance when viewed with the microscope. This type of muscle tissue is found mainly in the skeletal muscles. These muscle tissues are voluntary because they can be made to contract through conscious control.	 *A. Skeletal muscle* **Figure 2–5a. Skeletal muscle.**
Cardiac	The cells of cardiac muscle tissue are short, branched, contain one nucleus, and are striated or banded. This tissue makes up the myocardium or wall of the heart and is under involuntary control.	 *B. Cardiac muscle* **Figure 2–5b. Cardiac muscle.**
Smooth	The cells of smooth muscle tissue are spindle-shaped, containing one nucleus, and are not striated. Smooth muscle tissue is generally found in the walls of hollow organs such as the organs of the digestive and respiratory systems, blood vessels, ureters, urinary bladder, urethra, and reproductive ducts. These muscles are under involuntary control.	 *C. Smooth muscle* **Figure 2–5c. Smooth muscle.**

Nervous tissue

Nervous tissue is a collection of cells that respond to stimuli and transmit information concerning sensory feeling or motor control of muscles.

Neuron

A neuron, or nerve cell, is the cell of the nervous tissue that actually picks up and transmits a signal from one part of the body to another (fig. 2–6).

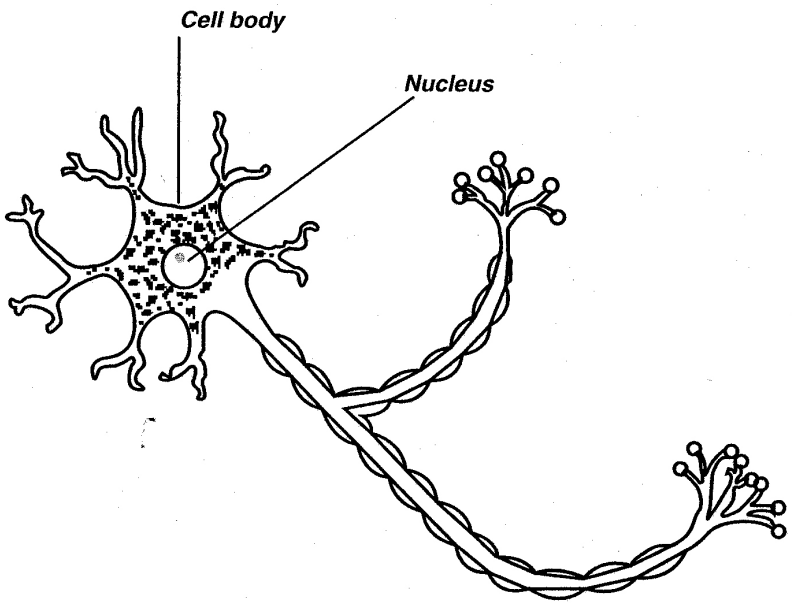


Figure. 2–6. Neurons.

A synapse is a junction between two neurons and is the point at which a signal passes from one neuron to the next (fig. 2–7).

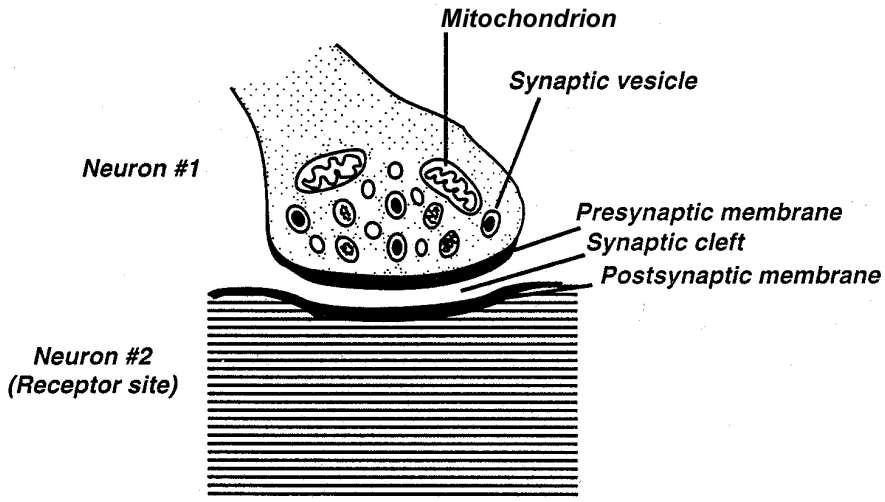


Figure. 2–7. Synapse.

Neuroglia

The neuroglia or glia are special cells that support and protect the nervous system. About 50 percent of the brain is made up of these glia or glial cells. The physiology of the nervous system is covered later in the volume.

Organs

Tissues make up organs. An organ is a structure composed of different types of tissues that perform a particular function such as the lungs or the heart. For example, the heart is composed of cardiac muscle, nervous tissue, and epithelial tissue.

Organ systems

An organ system is a group of organs that together perform an overall function such as the digestive system. The digestive system, which functions in the breakdown of food, is composed of the mouth, saliva-producing glands called salivary glands, pharynx or throat, esophagus or gullet, stomach, small intestine, large intestine, rectum, liver, gallbladder, and pancreas. All of these systems functioning together form an organism or one living individual.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

007. Body fluids

1. Where is extracellular fluid found?

2. Why is water called the universal solvent?

3. What are the two ways in which the human body obtains water?

4. What are ways that the human body can lose water?

5. What is the water loss called when sweat is not obvious?

6. What are four examples of dissolved substances carried in body fluids?

7. What do you call the body's tendency to maintain a steady state of balance?

8. What are the chemicals in the body fluids that dissociate into ions and must be present in certain proportions and concentrations in each fluid compartment?

9. What do you call the extracellular fluid that has a greater concentration of electrolytes than the intracellular fluid?

10. How does hypotonic extracellular fluid destroy the cell?

11. What is the characteristic of the cell membrane that does not allow all materials to pass through it?

12. What is the process by which water tends to pass through the cell membrane to the areas of greater concentration?

13. What is the term used to describe the cell membrane's engulfing a large particle such as bacteria or other cells?

14. What is the situation in living cells where there is generally a higher concentration of positively charged ions on the outside of the cell and a higher concentration of negatively charged ions on the inside of the cell?

15. What do you call the electrical gradient when there is a negative charge inside the cell and a positive charge outside the cell?

16. What do you call the electrical activity that occurs in stimulated neuron or muscle fiber?

008. Tissues and organs

1. What do you call groups of like cells that together perform a common function or functions?

2. What are grouped tissues that perform common functions called?

3. What do you call the tissue that covers surfaces and whose function is to protect, absorb, or secrete?

4. Which tissues support body parts in various ways?

5. What is the extracellular material called outside the fibrous connective tissue?

6. What is the function of loose areolar fibrous connective tissue?

7. Name two examples of dense fibrous connective tissues.

8. The elasticity of fibrous connective tissues is more or less proportional to what factor?

9. Where is the lipid portion of fatty tissues found?

10. What is another name for neutral fat?

11. What determines whether a triglyceride is either a liquid (oil) or a solid (fat)?

12. What is the major source of fat in the human body ?

13. What are two substances that are stored in the fat of the body?

14. Which muscle tissues are long and cylindrical and have numerous nuclei?

15. Which muscle tissues are short, branched, contain one nucleus, and are striated or banded?

16. What is the function of the neuron or nerve cell?

Answers to Self-Test Questions

005

1. The cell.
2. Chlorophyll.
3. The cell membrane or plasma membrane.

4. Genes.
5. Mitochondria.

006

1. Mitosis.
2. Hypertrophy.
3. Hyperplasia.
4. Atrophy.

007

1. In the interstitial fluid between the cells and in the circulating fluid called plasma.
2. Because of its ability to dissolve so many substances within itself.
3. Drinking and metabolic oxidation.
4. Perspiration, respiration, urination, and vomiting and diarrhea.
5. Insensible perspiration.
6. Gases, nutrients, wastes, and hormones.
7. Homeostasis.
8. Electrolytes.
9. Hypertonic.
10. Fluids enter the cell and cause it to swell and burst.
11. Semipermeability.
12. Osmosis.
13. Phagocytosis.
14. Membrane potential.
15. Resting potential.
16. Action potential.

008

1. Tissues.
2. Organs.
3. Epithelial tissue.
4. Connective tissues.
5. The matrix.
6. Filler material that allows organs to move freely over other structures.
7. Ligaments and tendons.
8. Temperature.
9. Inside the cell.
10. Triglycerides
11. The length of each fatty acid.
12. Diet.
13. Vitamins and organophosphate pesticides.
14. Skeletal muscle tissues.
15. Cardiac muscle tissues.
16. To pick up and transmit a signal from one part of the body to another.

Do the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter.

12. (005) Substances must pass through which typical animal cell component to get into the cell?
    a. Nucleus.
    b. Cell membrane.
    c. Organelles.
    d. Golgi complex.

13. (005) The basic units of heredity that pass from parents to their children are called
    a. genes.
    b. chromosomes.
    c. chromatin material.
    d. deoxyribonucleic acid (DNA).

14. (005) Which organelles are the "powerhouses" of the animal cell?
    a. Vacuoles.
    b. Lysosomes.
    c. Mitochondria.
    d. Endoplasmic reticulum.

15. (006) Cell multiplication is accomplished through a process called
    a. mycosis.
    b. myosis.
    c. mitosis.
    d. myopia.

16. (006) The release of stored energy from the combination of glucose and other nutrients with oxygen is called
    a. phosphate radical.
    b. metabolic oxidation.
    c. adenosine diphosphate.
    d. adenosine triphosphate.

17. (007) The human body *cannot* lose water through
    a. respiration.
    b. perspiration.
    c. metabolic oxidation.
    d. urination.

18. (007) What do we call the body's tendency to maintain a steady state of balance?
    a. Tissue fluid cycle.
    b. Hypertonicity.
    c. Hypotonicity.
    d. Homeostasis.

19. (007) What is the quality whereby the concentration of a substance is *greater* on one side of the cell membrane than the other, and water tends to pass *through* the membrane to the area of *greater* concentration?
    a. Osmosis.
    b. Diffusion.
    c. Pinocytosis.
    d. Phagocytosis.

20. (007) When a cell is in its resting state, what are the charges inside and outside the cell?
    a. More positive inside and negative outside.
    b. More positive outside and negative inside.
    c. Negative inside and outside.
    d. Positive inside and outside.

21. (008) Epithelial tissue is found in
    a. bones.
    b. muscles.
    c. intestines.
    d. tendons.

22. (008) The general functions of connective tissues are to protect, support, and
    a. separate.
    b. absorb.
    c. contract.
    d. bind together.

23. (008) Which is *not* a type of fiber found in loose connective tissue?
    a. Collagenous.
    b. Reticular.
    c. Elastic.
    d. Dense.

24. (008) What is the dense connective tissue that holds the bones together at a joint?
    a. Collagenous fiber.
    b. Reticular fiber.
    c. Ligament.
    d. Tendon.

25. (008) Which type of muscle tissue is under voluntary control?
    a. Cardiac.
    b. Smooth.
    c. Skeletal.
    d. All of the above.

26. (008) What makes up about 50 percent of the brain and includes special cells that support and protect the nervous system?
    a. Nervous tissue.
    b. Neurons.
    c. Synapses.
    d. Neuroglia.

Please read the unit menu for unit 3 and continue ➔

Unit 3. Anatomy and Physiology

YOU'VE already studied the basics of biology, including the structure of the human cell. You've also seen how cells are organized into tissues, organs, and organ systems. This unit covers the structures making up these organ systems, *anatomy*, and the functions these organ systems perform, *physiology*. A thorough understanding of anatomy and physiology will give you a deeper appreciation for medical conditions you've heard about. But more importantly, it provides the rationale for *why* many of our public health programs are conducted as they are. Medical terminology is found later in this volume. You may find it useful as you study this and other units.

3–1. Musculo-Skeletal System

The musculo-skeletal system provides the shape and support for the body. The skeleton and muscles not only protect the vital internal organs, but also work together to enable body movement.

009. Skeletal system

The skeletal system is made up of 206 bones and performs the following five major functions:

1. Supports surrounding tissues by providing a rigid framework within the body.
2. Assists in body movement by providing the site for muscle attachment. The interaction of a muscle contracting across a joint involving two or more bones causes the different parts of the body to move.

3. Protects the vital internal organs and other soft tissues. The skull surrounding the brain is an excellent example of this protective function.
4. Makes the red blood cells (RBC) and white blood cells (WBC) within the marrow of some the bones.
5. Stores mineral salts, especially phosphorous and calcium salts. These mineral salts are continuously removed and replenished and are essential for normal metabolic balance.

Axial and appendicular skeletons

As shown in figure 3–1, the axial skeleton is made up of the bones in the skull, the hyoid bones that support the larynx, the sternum, the 12 pairs of ribs, and the vertebrae. The vertebral column is further divided into 7 cervical vertebrae in the neck, 12 thoracic vertebrae where the ribs attach, 5 lumbar vertebrae of the lower back, and the sacrum formed by 5 fused vertebrae. You should realize that all these bones lie along the body's midline axis, thus the name *axial skeleton*. By contrast, the appendicular skeleton forms the appendages—arms and legs. The arms are attached to the axial skeleton through the shoulder girdle. The clavicle (collarbone) and the scapula (shoulder blade) form the shoulder girdle. The upper arm is supported by a single bone, the humerus, and the forearm is supported by two bones, the radius and the ulna. The legs are attached to the axial skeleton through several fused bones forming the pelvic girdle. The thigh is supported by the femur and the lower leg by the tibia and fibula. Note that the functional anatomy is very similar between the arm and leg. In both cases, the appendage is attached to the axial skeleton by a bony girdle. Next, the upper part of the extremity is supported by a single bone. Two bones provide the support to the lower portion of each limb.

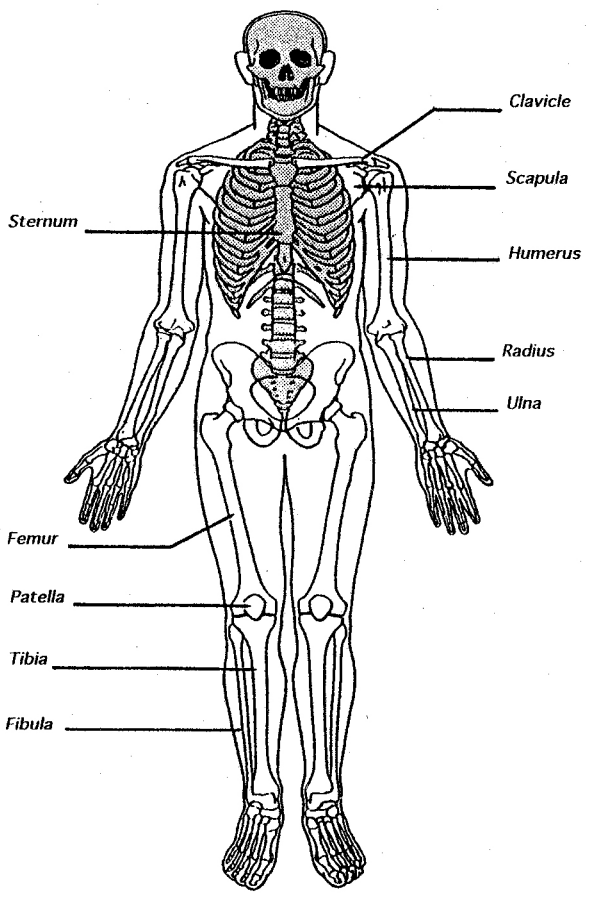


Figure 3–1. Axial skeleton (shaded areas); appendicular skeleton (nonshaded areas).

Accessory structures

There is more to the skeletal system than the bones themselves. The accessory structures hold the skeleton in its proper position and enable the bone surfaces to move smoothly over one another. One of the accessory structures is known as a ligament. Ligaments are fibrous bands that hold one bone to another. They are not very elastic and will tear if stressed in the wrong direction. Torn knee ligaments are a common football injury resulting from stresses applied to the side of the knee. Another accessory structure is the tendon. Tendons make the actual connection between a contracting muscle and a moving bone. Tendons are enclosed within

protective, lubricated sheaths that facilitate their sliding over adjacent structures. Joints are formed by the cartilage-covered ends of two moving bones. However, others, like the joints between the skull bones, are immovable and tightly fused.

Bone marrow

Another often overlooked part of the skeletal system is bone marrow. Bone marrow is the granular material we have all seen in the middle of the bone in a center cut of ham. Specifically, that material is yellow marrow and contains only fat cells, but elsewhere in the ribs, vertebrae, sternum, and pelvic bones we find red marrow. The red marrow is the production site for the RBC that carry oxygen in the blood and some WBC that are elements of the immune system. Since cellular activity in the red marrow is very high, external insults, such as ionizing radiation, may have a profound effect on the red marrow and, ultimately, on the organism.

Fractures

The last topic you'll study in regards to the skeletal system is fractures. As with most other medical topics, there exists a whole nomenclature associated with the classification of fractures. Only four of the most common fracture types are covered:

Type	Description
Simple	The bone is broken, but does not protrude through the skin.
Compound	The broken bone does protrude through the skin.
Comminuted	Exists when many small pieces and bone chips have been created.
Compression	Results from tremendous forces that cause the bone to telescope within itself. This type of fracture is common in the leg bones of people jumping from burning buildings.

No matter what the fracture type, the healing process is the same. The process begins with the formation of a *hematoma* (blood clot) caused from bleeding between and around the bone fragments. Later, the hematoma is infiltrated with small blood vessels and bone-forming cells as *granulation tissue* replaces the hematoma. Next, a *callus*, a large mass of loosely woven bone, forms and is remodeled according to the stresses acting on the bones. Finally, the fractured ends knit together with rigid bone, a process known as *ossification*. This entire process works well, but only if the bone fragments are put together and the bones are effectively immobilized. Any movement at all during this process may halt its progress and prevent the fracture from healing properly. This is why splinting fractured bones is an important first-aid measure. Later, after the bone has been set, if the physician notices that the bone pieces have slipped apart or if there is movement at the fracture site, the physician has to correct these problems or healing will not occur.

010. The muscular system

The muscular system serves the following five primary functions:

1. Functions in movement of the whole body and its appendages through muscular contraction and the resulting movement of the skeleton, the muscular system.
2. Moves blood throughout the body; both by contraction of the heart muscle moving blood through the arteries, and by the contraction of muscles throughout the body moving blood through the veins.
3. Moves food through the digestive tract by contractions of muscles located in the walls of the stomach, intestine, and other digestive organs.
4. Moves urine through the urinary tract.

5. Enables us to breathe due to the contractions of muscles in the chest, abdomen, and diaphragm

These five functions are absolutely essential to life itself, and the failure of any one of them will lead to death. Now that you've learned what the functions of the muscular system are, take a look at the different parts of muscles that perform these functions.

Anatomy

When you examine a muscle or think about a muscle in your own body (e.g., the gastrocnemius or calf muscle in your lower leg), you'll realize that it has three main parts—origin, belly, and insertion:

1. The origin is the fixed or stationary attachment of the muscle to the skeleton. In our example of the gastrocnemius muscle, the origin of this muscle is the back side of the femur or thigh bone.
2. The belly of a muscle is the large, fleshy prominence that forms the bulk of the muscle. Most of the muscle fibers that perform the actual work of contraction are located in the belly of the muscle.
3. The insertion of a muscle is the point on which the action of the muscle is applied, resulting in motion. As was mentioned earlier, the attachment between muscle and bone is a tendon. The gastrocnemius muscle inserts on the heel bone by way of the Achilles' tendon.

So much for the anatomy of muscles. Now you'll examine exactly what takes place when a muscle contracts.

Mechanism of contraction

Within each muscle are tiny muscle fibrils (fig. 3–2). These myofibrils are composed of two different types of proteins, actin and myosin. Cross bridges connect the proteins to each other. When stimulated by a nerve impulse, the cross bridges "reach out" from a myosin filament, attach to an actin filament and pull the actin filaments inward. This pulling shortens the muscle fibrils, and when it takes place throughout a muscle, it shortens the overall length of the muscle. This microscopic method of contraction involving the proteins actin and myosin is also called *the sliding filament mechanism.* (fig. 3–3).

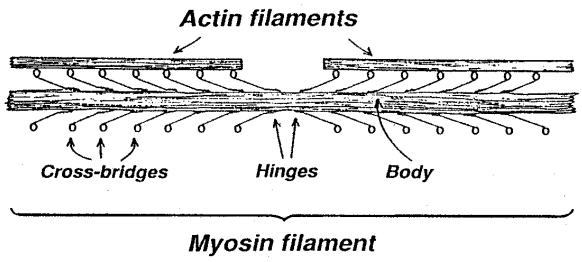


Figure 3–2. Muscle filaments.

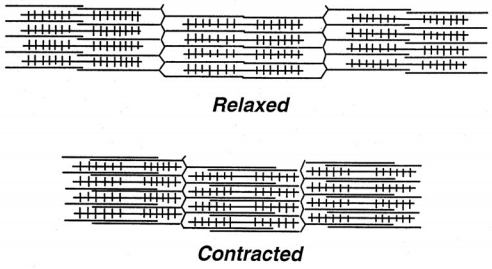


Figure 3–3. Muscle contraction.

Myoglobin

Another protein found in muscles is myoglobin. As you may have guessed from its name, myoglobin is the muscle tissue's answer to hemoglobin. Like hemoglobin, myoglobin can store oxygen until it is needed by the cell. Large amounts of oxygen are needed by a muscle cell when it contracts. An interesting correlation exists between the color of meats, the type of work the muscle performed for the animal, and its myoglobin content. Chickens are not

renowned flyers, in fact they fly very poorly. But they and their wild relatives are adept at fleeing on foot. Not surprisingly, then, since little work is performed by the breast muscles and great work is done by the thighs and legs, breast meat contains less myoglobin than does the thigh or leg muscles. The low myoglobin content in breast meat makes it paler than the dark meat of the thigh and leg tissue, which contains more myoglobin. Unlike chickens, ducks are excellent flyers and can travel thousands of miles on their annual migrations. The breast muscles of the duck perform great amounts of work and are rich in myoglobin; therefore, the breast meat of duck is quite dark. Meat color can also be influenced by diet. Veal calves are fed milk, a food very low in iron. Iron is a component of myoglobin (as well as hemoglobin). Since these calves receive insufficient amounts of iron, they produce insufficient amounts of myoglobin in their muscle tissue. This deficiency results in a meat that is very light in color. Finally, pork is lighter in color than beef because, as a species, hogs produce less myoglobin than do cattle.

You've studied three muscle proteins—actin, myosin, and myoglobin. There are other proteins that are important to us in public health, and these special proteins are called enzymes.

Enzymes

Enzymes are present in many tissue cells, not just muscle, and enable the cells to perform different metabolic jobs. Some enzymes are found only in certain tissues, while other enzymes are common to several types of tissue. *Serum glutamic oxaloacetic transaminase* (SGOT), also known as *aspartate amino transferase* (AST), is an enzyme found in several tissues including liver, muscle, and brain. When these tissues are damaged, SGOT leaks from the damaged cells into the bloodstream and can then be found in high levels in blood samples. In the public health field, we commonly use SGOT to evaluate liver toxicity for those taking isoniazid (INH) as a result of tuberculous infection. You must remember, though, that SGOT is not liver specific. A person who has recently exercised may have elevated SGOTs from the muscle tissue damage caused by extensive exercise. However, those who exercise regularly do not damage muscle cells during exercise and will probably add muscle bulk through a process known as muscular hypertrophy.

Muscular hypertrophy and atrophy

These two terms are opposites. Hypertrophy is the process of increasing both the size and number of muscle fibers. As you know, forceful muscular activity will, over time, result in muscular hypertrophy. But, no new myofibrils will develop unless the muscle contracts to 75 percent of its maximum ability. The point is, short, hard workouts will do more to build strength and muscle mass than will prolonged, mild workouts that never push the muscle groups to 75 percent of their capability. As you learned earlier, the opposite of hypertrophy is atrophy, and atrophy is a wasting away of the muscle. There are two causes of atrophy—(1) loss of the nerve supply to the muscle and (2) lack of use. When the nerve supply to a muscle is cut or interrupted, the muscle very rapidly and dramatically atrophies. Evidently, the muscle is very dependent on the nerve for its normal metabolism. A more common cause of atrophy is disuse. Disuse atrophy occurs when the muscle is not used; for example, when a limb is in a cast or when there is long-term confinement to a bed. This type of atrophy is reversible, and with routine exercise, the muscle will regain its former size and function.

Trichinosis

The last condition affecting the muscular system is caused by the parasitic worm, *trichinella spiralis*. Trichinosis is a disease affecting the muscles of both animals and man. Infection results from eating meat containing infective *trichinella* cysts. Within the digestive tract, the

cysts break open and the worms migrate through the body tissues until they reach muscles where they, too, encyst. The presence of these cysts in the muscles is quite painful, but this disease can be prevented by properly and thoroughly cooking all meats. In the past, most cases of trichinosis resulted from eating undercooked pork—hence the public education efforts on the importance of thoroughly cooking pork. Recently, though, most reported cases have occurred after people on hunting trips have eaten undercooked, home-prepared portions of polar bear or other large trophy animals.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

009. Skeletal system

1. What makes up the appendicular skeleton?

2. Which bones form the shoulder girdle?

3. What makes the actual connection between a contracting muscle and a moving bone?

4. What is a comminuted fracture?

5. What is a callus?

010. Muscular system

1. What is the microscopic method of contraction involving the proteins actin and myosin called?

2. What causes the darker meat in animals, especially the meat of working muscles?

3. What is another name for serum glutamic oxaloacetic transaminase (SGOT)?

4. What are the two causes of muscle atrophy?

5. What is trichinosis and what causes this condition?

3–2. Circulatory and Respiratory Systems

The circulatory and respiratory systems work together to deliver oxygenated blood to and remove carbon dioxide and other metabolic byproducts from body tissues.

011. Circulatory system

In addition to transporting different gases, hormones, nutrients, and waste products around the body, the circulatory system helps regulate body temperature. When the outside temperature is hot, capillaries in the skin dilate or enlarge to allow more blood to flow through the skin. Since the skin is in contact with the air, it acts as a large radiator to transmit heat from the blood to the air. When the outside temperature is cold, the capillaries of the skin constrict or close down to reduce heat transfer through the skin to the environment, thus conserving available body heat.

Now, turn your attention to the largest part of the circulatory system, the blood.

Blood

Although blood appears as a fluid, there are cellular components, the "formed elements," and a fluid component. Forty-five percent of blood is made up of the three main types of blood cells: (1) red blood cells (RBC), (2) white blood cells (WBC), and (3) platelets.

RBC, or erythrocytes, make up 99 percent of the total number of cells in the blood. These cells have no nucleus, but are rich in hemoglobin, the oxygen carrying protein of blood. The normal life span of RBC is about 4 months. An insufficient number of RBC causes anemia, which is a decrease in the oxygen-carrying ability of the blood.

White blood cells, or leukocytes, function as part of the body's immune system to eliminate foreign material by producing antibodies. There are five different types of leukocytes, all have a nucleus and all are produced in the bone marrow:

1. Platelets are tiny cell fragments that break off from large cells in the bone marrow. The platelets then enter circulation and assist in blood clotting after an injury.
2. Plasma is the fluid fraction remaining after all the formed elements are removed from the blood. Plasma contains 91 percent water. If plasma is allowed to stand undisturbed, it will clot, and the liquid component left after the clot is removed is called serum.
3. In addition to the clotting proteins, blood contains other proteins. Some of these proteins determine the blood type under the ABO blood grouping system. If a person is transfused with the wrong blood type, the resulting reaction can be fatal.
    a) Group A blood contains A antigens and anti-B antibodies.
    b) Group B blood contains B antigens and anti-A antibodies.
    c) Group AB contains both A and B antigens but no antibodies.
    d) Group O blood contains no antigens, but both anti-A and anti-B antibodies. After a little thinking, you should understand that because type O contains no antigens, it can be transfused into anyone; it's the universal donor. Conversely, because

type AB contains no antibodies, any blood type can be transfused without reaction; it's the universal recipient.

4. The Rh factor, first identified in Rhesus monkeys, identifies the presence or absence of another antigen, the Rh antigen. If the Rh antigen is present, the blood is called Rh positive. If absent, the blood is Rh negative. Transfusion reactions can occur following transfusion of Rh positive blood into a Rh negative recipient.
5. The last blood component reviewed is hemoglobin. Hemoglobin is an iron-containing protein that accounts for 98 percent of the oxygen carrying capacity of the blood. As you know, diets deficient in iron can cause anemia or iron-poor blood, which reduces the blood's capability to transport oxygen.

Having looked at the blood, turn your attention to the pump that moves the blood to the tissues—the heart.

Heart

Your heart, about the size of your fist, is located in the left center of your chest. It is surrounded by a membranous sac, the pericardium. If the heart or pericardium is damaged, the pericardium could fill with blood, compress the heart, and restrict its proper filling and pumping.

The heart (fig. 3–4) is divided into two pairs of chambers, the right *atrium* and *ventricle* and the left *atrium* and *ventricle*. Valves separate the atrium from its corresponding ventricle and the ventricle from the artery leaving it. Blood low in oxygen returning from the body enters the right atrium through the *vena cava*. As the right atrium contracts, this blood is pumped through the tricuspid valve into the right ventricle. When the right ventricle contracts, blood is forced out of the pulmonary artery to the lungs where carbon dioxide in the blood is exchanged for oxygen in the lungs. Oxygen-rich blood then returns from the lungs to the left atrium through the pulmonary veins. The left atrium contracts, forcing blood through the mitral valve into the left ventricle. When the left ventricle contracts, blood moves out through the aorta and on to all body tissues. These contractions take place in a coordinated, two-step rhythm. First, both atria contract fillng the ventricles, then both ventricles contract forcing blood into the pulmonary and systemic circulatory systems. These two separate circulatory systems separate the oxygen-rich blood and oxygen-deficient blood, and ensure that only oxygen-rich blood is pumped from the heart to the body.

Although great volumes of blood pass through the heart, the heart itself has its own system of blood vessels called coronary vessels, supplying its needs.

Vessels

The main arteries supplying the brain are the carotid arteries. The carotid pulse can be felt in the neck, alongside the windpipe. The brachial arteries supply the arms, and the brachial pulse can be felt on the inside of the upper arm. The femoral artery enters the leg in the groin area. Regardless of which tissue is supplied, all of these arteries eventually branch into arterioles, which, in turn, branch into capillaries. The capillaries are the tiny vessels that actually carry the blood through the tissue. After leaving the tissues, the venous capillaries carry venous blood to venules, which join to form veins. Eventually, these veins return the blood back to the heart.

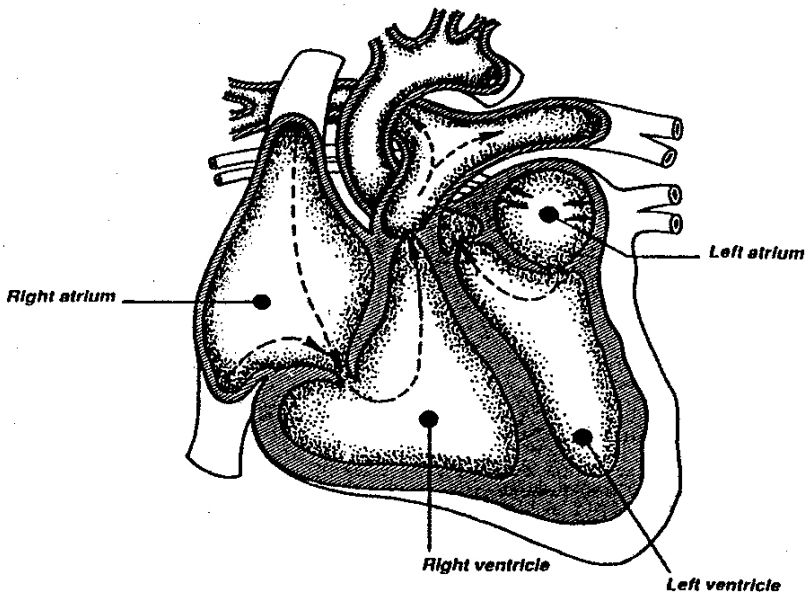


Figure 3–4. Chambers of the heart.

Shock

If there is an insufficient volume of blood to meet the body's needs, the condition is known as circulatory shock. The most common reason for an insufficient blood volume is bleeding, because circulating blood volume is low, blood pressure will also drop. This series of events can be life threatening and must be rapidly corrected. Therapy usually involves increasing blood volume as quickly as possible by administering large amounts of IV fluids. These fluids can be whole blood, plasma, or various salt solutions like lactated ringers solution. Shock may be secondary to another injury; however, the person may not live to have the primary injury treated unless the shock is corrected first. Excessive loss of fluids through vomiting and diarrhea can also lead to circulatory shock.

012. Respiratory System

The maintenance of life depends on a sufficient supply of oxygen (O_2) and the removal of carbon dioxide (CO_2). The respiratory system functions in this gas exchange between the organism and the environment. Take a look at the anatomy of the respiratory tract to determine how it carries out this function.

Anatomy

You'll study the anatomy in the same order as air passes through the respiratory tract, beginning with the nose. After air enters the nostrils, the bones within the nose, called turbinates, deflect the air from a straight pathway causing it to twist and turn. This tortuous pathway, as well as the hairs inside the nose, cause fine particles like dust to be filtered out before passing further down the tract. In addition to filtration, the nose also warms and humidifies the air on its way to the pharynx.

The pharynx is the common passageway for both the respiratory and digestive systems. Air then moves into the larynx or voice box. As you know, the main function of the larynx is phonation, or the production of sound. The pitch of these sounds is controlled by changing the shape and tension of the vocal chords. Just like the strings of a guitar, thin, high tension vocal chords produce a higher pitch than thick, low tension vocal chords. As you can see in

figure 3–5, several cartilages form the larynx. The large butterfly-shaped cartilage in front is the thyroid cartilage. Below this is the ring-like cricoid cartilage and the membrane between these two cartilages, called the cricothyroid membrane. This membrane is punctured in an emergency procedure called a cricothyrotomy to provide an open airway in the event of upper airway obstruction.

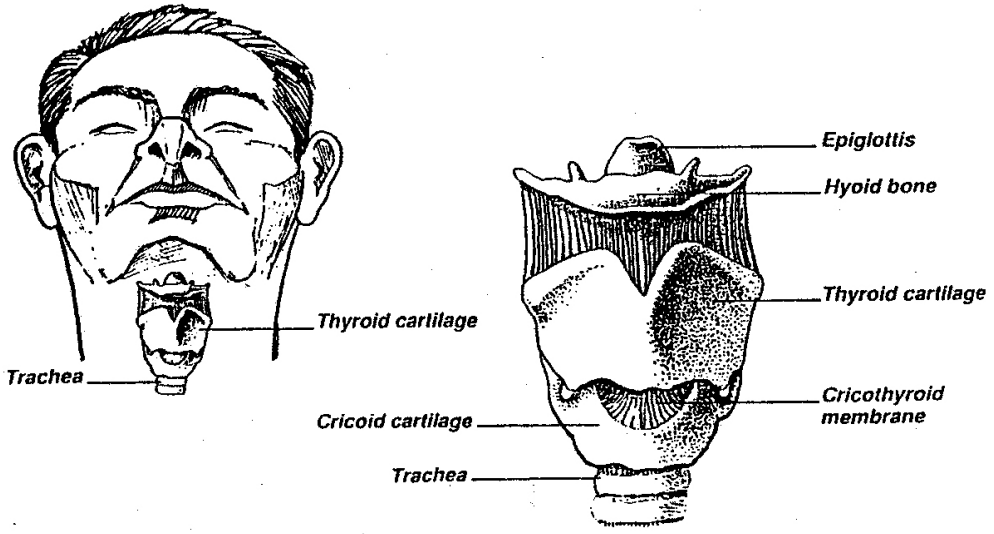


Figure 3–5. Larynx.

The trachea or windpipe exits the larynx and carries the air into the chest cavity. It is made of a series of cartilage rings. These cartilages can be cut during a tracheotomy as another means of providing an emergency airway should obstruction occur in the upper airway. Much of the trachea and other parts of the respiratory tract are lined with small hair-like projections called cilia. These cilia perform an extremely important protective function for the respiratory tract. They rhythmically beat in the direction of the pharynx, moving debris trapped within a protective mucous coat. When the material reaches the pharynx, it is either swallowed or expectorated (coughed up or spit out). Cigarette smoke and other airborne contaminants can paralyze the cilia and, thus, eliminate one of the most effective protective mechanisms of the respiratory tract.

Within the chest, the trachea divides into two bronchi, which divide even further to form bronchioles. Eventually, a tiny airway will lead to an alveolus. The alveoli, which is the plural form of alveolus, are the actual sites of the gas exchange. These grape-like clusters of cells provide very thin membranes between the blood contained within capillaries and the air within the alveolus. Oxygen and carbon dioxide readily cross these membranes in response to pressure gradients.

Relative pressures

Referring to figures 3–6 and 3–7, you can see that the pressures of oxygen and carbon dioxide in the alveolus are 104mmHg and 40mmHg, respectively. Blood flowing through the capillary approaches the alveolus with the pressures of oxygen at 40mmHg and carbon dioxide at 45mmHg. Since this blood entering the lung contains less oxygen and more CO_2 than the air in the alveolus, oxygen moves from the alveolus into the blood, and carbon dioxide moves from the blood to the alveolus. By the time the blood leaves the lungs, the oxygen pressure has been raised to 104mmHg and the carbon dioxide pressure has been lowered to 40mmHg, the same pressures found in the inspired air in the alveolus (fig. 3–7).

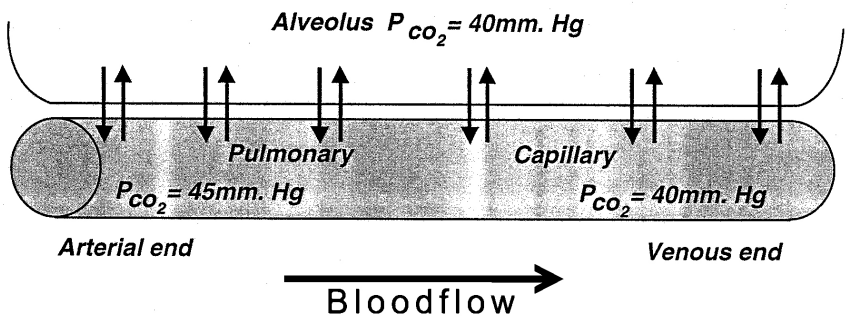


Figure 3–6. Blood pressure and oxygen transfer to alveoli.

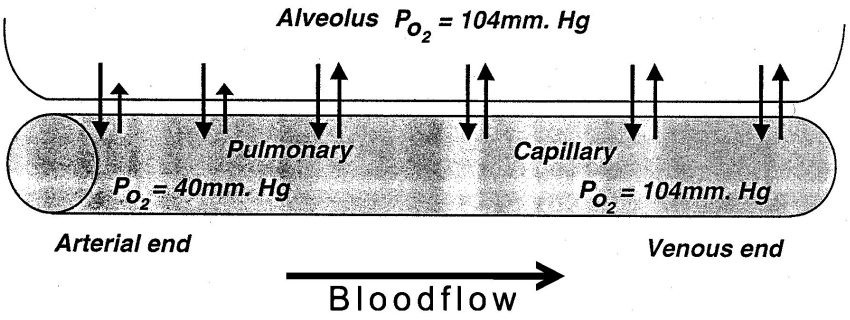


Figure 3–7. Blood pressure and oxygen resistance to transfer to alveoli.

These pressures are dramatically changed, though, as pilots ascend to high altitudes in aircraft. At 10,000 feet, the pressure of oxygen is only about 70 percent of the value at sea level. At 50,000 feet, the oxygen pressure is only about 11 percent of the value at sea level. Although the pressure of oxygen in air changes with altitude, the same pressures exist in the human bloodstream, regardless of the altitude. It's easy to see that the pressure gradients that cause the necessary movements of oxygen and carbon dioxide do not work effectively at high altitudes. This is why aircrews carry supplemental oxygen and aircraft cabins are pressurized to approximate sea-level conditions.

Interestingly enough, hemoglobin, which normally carries oxygen, will bind other gases as well. For example, it binds with carbon monoxide 210 to 250 times more readily than oxygen. Therefore, only very small concentrations of carbon monoxide can prevent oxygen binding and cause death.

You've learned how the gases move in and out of the bloodstream and the alveoli. But how is the air actually moved in and out of the respiratory system? You'll see as you study the mechanics of breathing.

Mechanics of breathing

The abdominal and thoracic (chest) cavities are separated by a heavy sheet of muscle called the diaphragm. Between the lungs and the wall of the thorax, negative pressure or a vacuum exists. This negative pressure causes the lungs to be fully expanded to the maximum limits allowed by the confines of the thoracic cavity. As the diaphragm contracts and the chest walls are expanded during inspiration, the volume within the thorax is increased. The negative pressure causes the lungs to expand and fill the increasing thoracic volume. As the lungs are expanded outward, air is drawn in through the nose and down the trachea to fill the newly created space within the lungs. On expiration, the diaphragm relaxes and the chest wall falls, both compressing the lungs. As the lungs are compressed, the air is forced out of the

respiratory tract to the outside. This arrangement works very nicely as long as the thoracic cavity is able to maintain the required negative pressure. However, should the integrity of the thoracic cavity be broken, outside air will flow into the chest cavity and the negative pressure expanding the lungs will be lost (e.g., a sucking chest wound). Efforts to expand the chest wall will be fruitless, and as a result, no air will be moved in or out of the lungs. This condition, called pneumothorax, can occur any time a penetrating chest wound occurs. It can be corrected by inserting a chest tube and drawing out the accumulated air. This procedure re-establishes the negative pressure required to keep the lungs fully expanded within the confines of the chest cavity.

Pathology

The first topic you'll study under pathology deals with the action of different chemical warfare agents on the respiratory system. Cyanide, a blood agent, prevents the body tissues from using the oxygen carried by the blood's hemoglobin. The blood contains plenty of oxygen, the mucous membranes and fingernail beds have a healthy pink color, but the tissues are dying from a lack of oxygen. When choking agents are inhaled, they cause severe irritation to the respiratory tract. This irritation causes the fluid components of the blood, normally contained within the pulmonary capillaries, to pass through the vessel walls into the alveolus. This fluid accumulates in the lungs and interferes with the normal oxygen-carbon dioxide exchange process. This condition, sometimes referred to as "dry-land drowning," is known medically as pulmonary edema. Having reviewed the respiratory pathology associated with chemical warfare agents, you'll now learn a few naturally occurring conditions.

Condition	Explanation
Pneumonia (also called pneumonitis)	Is caused by a variety of agents including bacteria, viruses, fungi, and chemicals. As white blood cells and fluids accumulate in the lungs, gas exchange is impaired.
Asthma	An allergic response causing a narrowing of the small airways making it difficult to move air in and out.
Emphysema	The destruction of lung tissue and the blockage of small bronchioles makes less lung tissue available for gas exchange and increases the labor of breathing.

A worker with any of these conditions may have enough respiratory problems already without being required to work wearing a respirator.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

011. Circulatory system

1. Besides transporting gases, hormones, nutrients, and waste products, what is the second major function of the circulatory system?

2. Which type of blood cells make up 99 percent of the total number of cells in the blood?

3. What is the condition of having an insufficient number of red blood cells called?

4. A person having blood containing B antigens and anti-A antibodies has which blood type?

5. What antigen is present in a person having blood type O positive?

6. What is the name of the membranous sac that surrounds the heart?

7. Which portion of the heart receives oxygen-rich blood from the lungs?

8. What is the condition called where there is an insufficient volume of blood to meet the needs of the body?

012. Respiratory system

1. What are the bones in the nose called that twist and turn the air as it enters?

2. What emergency procedures could be performed in the event of upper airway obstruction?

3. What carries air into the chest cavity?

4. What is the name of the muscle separating the abdominal and thoracic cavities that creates breathing?

5. What is the condition called where no air goes into or out of the lungs due to a penetrating chest wound?

6. What is the medical terminology for “dry-land drowning? ”

3–3. Digestive and Urogenital Systems

Although these organ systems perform a variety of different functions, they both perform the vital role of eliminating solid wastes from the body. The digestive system eliminates the unused byproducts of ingested food, while the kidney filters metabolic impurities from the blood.

013. Digestive system

Living organisms can survive only if adequate raw materials are available to supply energy and support growth, maintenance, and repair. Although the circulatory system actually transports these materials to and from the tissues, they are made available through the digestive and absorptive functions of the digestive tract. Digestion involves both mechanical (chewing) and chemical (enzymatic and acidic) breakdown of food into components that can be absorbed through the walls of the digestive tract into the bloodstream. The absorptive function is carried out by cells throughout the tract, but only certain components are absorbed from the gut contents. Finally, after the food has been digested and the useful materials absorbed, the digestive system performs its third function, elimination of the unusable wastes.

The digestive system can be divided into two main elements—the alimentary canal and the accessory glands, which secrete chemicals important in the digestive process. First look at the tube that carries the food through the body, the alimentary canal.

Alimentary canal

The alimentary canal begins at the mouth and ends approximately 28 feet later at the anus. The digestive process begins in the mouth as saliva is mixed with food, and the food is broken down into smaller particles by the process of chewing. When the food is swallowed, it moves through the pharynx and into the esophagus. The esophagus is a muscular tube passing through the thorax and diaphragm. Food is moved by gravity and muscular contractions through the esophagus and into the stomach.

The stomach, lying primarily on the left side of the body, is the most dilated portion of the digestive tract. It functions as a holding vat, storing food after a meal, and then, over time, releasing small amounts into the intestine. Digestion also takes place in the stomach. Protein digestion begins with the release of the enzyme pepsin. The gastric secretion of hydrochloric acid also helps digestion by breaking down food into smaller particles. The stomach itself is protected from the acid secretions by a heavy mucous coating. If the coating is incomplete, the hydrochloric acid begins to digest the stomach wall. This condition, which can also occur in the first section of the small intestine, is known as an ulcer. The erosion of blood vessels in the stomach wall can cause a chronic blood loss or massive acute bleeding, depending on the vessels involved.

Besides hemorrhage, there are other types of stomach inflammation that exist. When the stomach is inflamed by bacterial toxins or other irritants, it will try to rid itself of these materials. Vomiting is, thus, a protective mechanism for eliminating potentially dangerous contents from the upper gastrointestinal tract.

Leaving the stomach, food enters the small intestine, which is approximately 18 feet long. The small intestine is lined by a large number of finger-like protrusions called villi. These villi are microscopic projections that greatly increase the absorptive surface area of the small intestine. In fact, the small intestine is the area of greatest nutrient absorption within the digestive tract.

The cecum is a blind pouch attached at the junction of the small intestine and the next section of the gut, the large intestine. The appendix lies at the end of the cecum and is called a

vestigial organ. Vestigial organs serve no useful purpose, and indeed, the only time we are really interested in the appendix is when it becomes inflamed and is removed during an appendectomy.

The next section of the alimentary canal is the large intestine. Besides nutrients, there is another material essential to life absorbed within this section of the alimentary canal. The material is water, and more is absorbed in the large intestine than anywhere else in the gut. The large intestine also serves to store fecal material until expelled. The fecal material moves through the large intestine into the rectum, and is eliminated through the anus. Just as the upper gastrointestinal tract has a protective mechanism for eliminating irritants, the process of vomiting, so does the lower gastrointestinal tract. As the irritant passes through the small and large intestine, it causes the gut to secrete more fluids and to increase its normal contractions. These two factors work together to sweep the irritant out of the intestinal tract as quickly as possible, resulting in diarrhea. Cholera toxin directly stimulates the gut cells to increase their secretions, and the excessive fluid loss can result in rapid and severe dehydration.

Having discussed the different sections of the alimentary canal, now you'll examine the digestive system's accessory structures.

Accessory structures

These structures (all are glands) do not perform any of the absorption duties; instead, their secretions aid the digestion processes. You've already briefly studied the salivary glands and their secretions.

Parotid salivary glands

Actually, there are several salivary glands. But, the parotid salivary glands lie under the jawbone and are the target of the mumps virus and become quite swollen when inflamed. With the trivalent measles, mumps, rubella (MMR) vaccine, mumps is much less common today than a few years ago.

Pancreas

The pancreas secretes digestive enzymes into the small intestine through small ducts. These enzymes function in the digestion of all three major nutrient groups—proteins, carbohydrates, and fats.

Liver

Is a large and an important accessory structure. Besides producing bile, which aids in the digestion and absorption of fats, the liver performs many other functions, including producing blood clotting factors and detoxifying certain chemicals. The liver also excretes bilirubin, which is a breakdown product formed from the hemoglobin in RBC. As RBC reach the end of their 4-month life span, they rupture and release their hemoglobin. The hemoglobin is degraded to bilirubin and is then filtered from the blood by liver cells. Eventually, the liver cells incorporate this bilirubin into bile, which is secreted into the small intestine. If the bile duct leading into the intestine becomes blocked or the liver cells are damaged and unable to process the bilirubin, this yellow chemical accumulates to high levels in the bloodstream. This causes a yellowing of the skin and eyes known as jaundice. Thus, jaundice is an indication of liver damage and is a symptom in persons adversely reacting to isoniazid (INH), a medication taken for tuberculous infection.

Gallbladder

This small pear-shaped reservoir is located between two lobes of the liver. The gallbladder stores concentrated bile and releases it when it is needed to digest a high fat meal.

014. Urogenital system

The urogenital system is composed of the urinary system and the reproductive system. They have very different functions, yet anatomically are closely related. First you'll study the urinary system.

Structure and function of the urinary system

The urinary system has an excretory function. Other organs also having an excretory function are the large intestine, skin, and lungs. Blood passes through the two kidneys where urine is formed. The urine is carried from each kidney by a ureter to the urinary bladder, where it is stored until it is voided. The last portion of the urinary tract is the urethra, which carries the urine from the bladder to the outside (fig. 3–8).

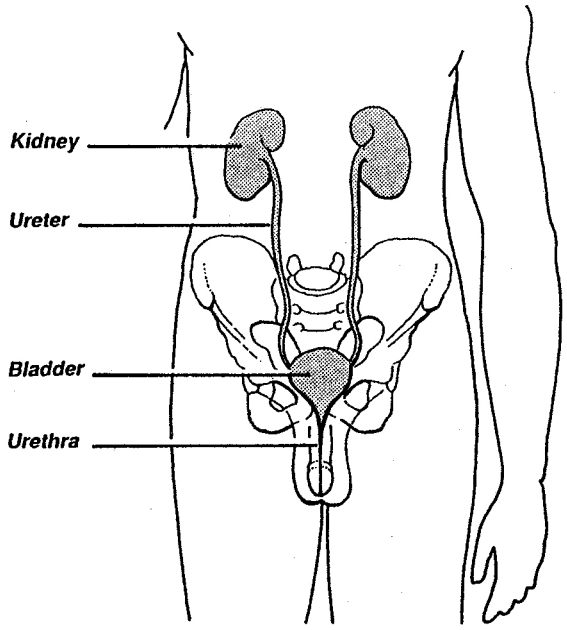


Figure 3–8. Urinary system.

Urine formation

Approximately 1,200 ml of blood (1/4 of the total cardiac output) passes through the kidney per minute. As blood passes through the kidney, a filtrate (filtered fluid) very similar to plasma is produced. For every 125 ml of filtrate produced, only 1 ml leaves the kidney as urine. Through the process of reabsorption, useful components, like glucose, sodium, and water, are removed from the filtrate and returned to the circulation. Other substances, like organic acids produced by metabolic processes in the body's cells, are secreted into the forming urine. The final concentration of the urine is determined by the body's need to conserve water. If the body is well or overhydrated, a diluted urine is produced. When dehydrated, water is conserved by the kidneys forming very concentrated urine. The kidney's ability to produce concentrated urine is one measure of its normal function.

Urine analysis

The urine analysis (UA) is commonly performed in hospital laboratories to assess kidney health and function. By comparing the amounts of different organic and inorganic compounds excreted in the urine, trained observers can gain insight into the function of the kidney and several different body systems. Additionally, a microscopic examination of the urine sediment may identify specific damage to the kidney cells.

Reproductive system

Having covered the urinary system, you'll focus on the other main component of the urogenital system, the reproductive system.

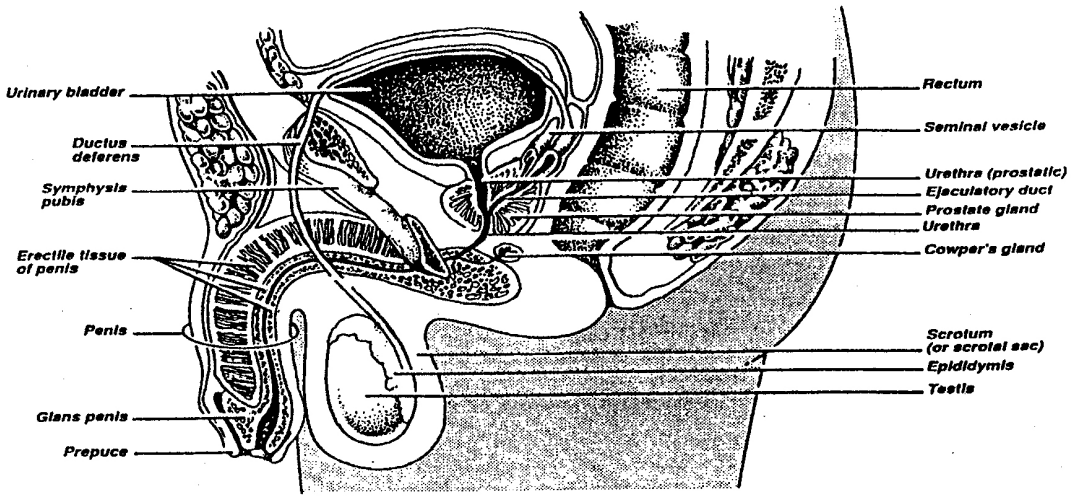


Figure 3–9. Male reproductive system.

Structure of the male reproductive system

The reproductive organs consist externally of the penis and scrotum. Internally, the system is made up of several glands and the ducts that connect these glands (fig. 3–9).

Part	Explanation
Penis	Is composed of erectile tissue (spongy mass of blood vessels). During stimulation, arteries dilate and veins constrict, allowing blood to flow in, but not out, causing the penis to become erect. The end of the penis is covered by a structure called the prepuce or foreskin. Frequently, the foreskin is removed during the first few days of life—a procedure called circumcision. This operation is done to prevent irritation and facilitate cleanliness.
Scrotum	Is an external pendulous sac containing the testes and epididymis. The external location of the scrotum keeps the temperature of the testes lower than body temperature. This is necessary for proper sperm development.
Testis	Is the singular form of testes, which are two oval-shaped glands suspended by the spermatic cords in the scrotum. They originate in the abdomen of the male fetus and descend into the scrotum about 2 months before birth. Occasionally, a child is born with undescended testes and must undergo surgery to bring the testes into the scrotum.
Urethra	Is a tube-like structure extending from the bladder to the external meatus (opening) of the penis. The urethra transmits urine from the bladder during urination and sperm from the testes during ejaculation.
Epididymis	Is the first part of a long duct or tube leaving the testes. The epididymis is a tightly coiled tube and sperm enter the epididymis for final maturation and storage. The continuation of the tube after the epididymis is called the vas deferens and it is important in transmitting sperm to the urethra during ejaculation. The vas deferens is the site of a common birth control procedure in males called a vasectomy. In this procedure, a portion of the vas is removed and the two ends sealed. The male continues to produce sperm normally, but the sperm are not able to reach the urethra.
Seminal vesicles	Is a gland that secretes nutrients for sperm.
Prostate	Is a doughnut-shaped gland that lies below the bladder. The urethra passes through the center of the prostate. It secretes a fluid to increase the motility of the sperm and protects sperm from the acid environment of the female tract.

Function of the male reproductive system

The testes are responsible for hormone and sperm production. Testosterone, the primary male hormone, directs sexual differentiation (in males) during early fetal development. Production increases at onset of puberty and results in secondary male characteristics such as facial hair,

deepening voice, and increased musculature. Sperm production, known as spermatogenesis, is a continuous, cyclical 74-day renewing process. Sperm cells (spermatogonia) mature into spermatids through a series of cell divisions. Spermatids have 23 chromosomes, which is half of the 46 chromosomes in the parent cells. Spermatids develop in the seminiferous tubules and when released are non-motile and incapable of fertilization. Final maturation and storage occurs in the epididymis.

Structure of the female reproductive system

The female reproductive system includes the vagina, cervix, uterus, fallopian tubes, ovaries and external genitalia (fig. 3–10).

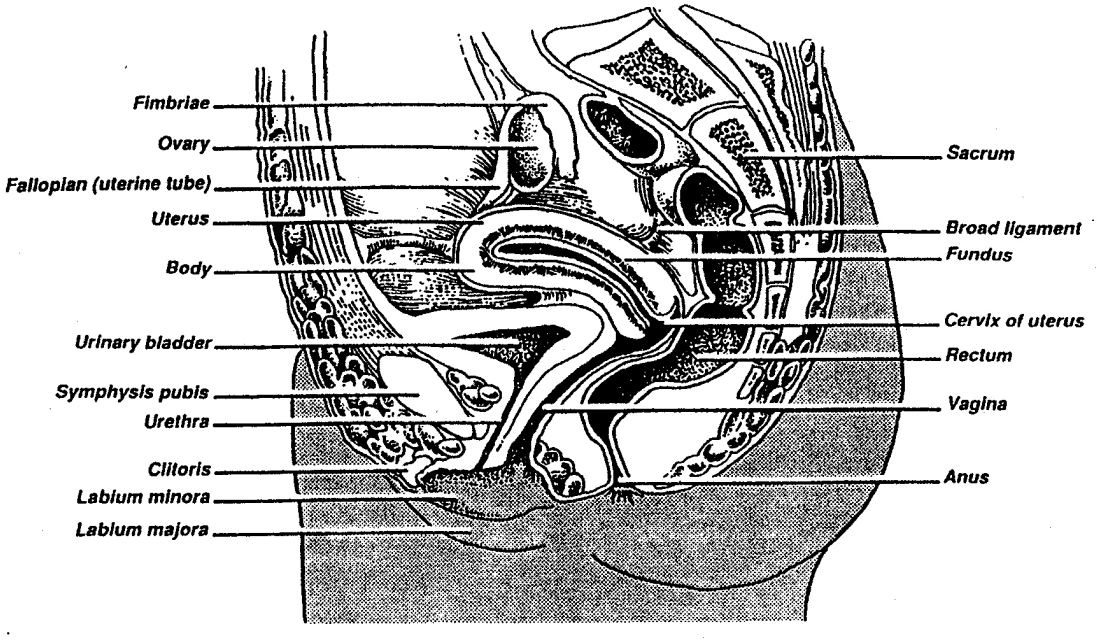


Figure 3–10. Female reproductive system.

Part	Explanation
Vagina (or birth canal)	Is a collapsed muscular tube. It is capable of tremendous amount of expansion during the birthing process.
Cervix	Is a fibrous tube between the vagina and uterus. The cervix normally closes during pregnancy, helping to maintain the pregnancy.
Uterus	Is a muscular organ with a glandular inner lining. The uterus nourishes the implanted embryo during pregnancy. At the end of the pregnancy, the uterine muscles undergo powerful rhythmic contractions to expel the infant.
Fallopian tubes (or oviducts)	Are hollow tubes which stem from each side of the uterus. Fringe-like structures called fimbriae are located at the end of each fallopian tube and partially surround each ovary. However, there is no direct communication or linkage between the tube and ovaries. When an ovum is discharged from the ovary, it enters the abdominal cavity. The fimbriae draw ovum into the fallopian tubes. If sperm are present in the fallopian tubes, fertilization occurs and the fertilized ovum travel into the uterus for implantation. The open fallopian tubes create a direct channel from the outside environment into the abdomen; this enhances the potential for serious disease, especially abdominal complications of sexually transmitted diseases.
Ovaries	Are the two oval-shaped structures located in the abdominal cavity on each side of the uterus. These organs produce the female sex cells called ova and the female hormones, estrogen and progesterone.

Function of the female reproductive system

The ovaries are responsible for hormones and ova production. What are the hormones used for within the female?

Hormone production

The hormone estrogen is produced by the ovaries then released into the bloodstream. Estrogen is responsible for sexual differentiation in females, increased growth of the uterus and vagina, and repair of the uterine lining after menstruation. Progesterone is also produced by the ovaries and is important in preparing the uterus for implantation of the fertilized ovum and in maintaining pregnancy.

Oogenesis

Unlike spermatogenesis, oogenesis is not a continuous process. Approximately seven million stem cells called oogonia are produced by the 7th month of fetal life. By puberty, this number has fallen to around 400,000. Of that number, only 400 will become capable of ovulation. During oogenesis, oogonia mature by a series of cell divisions similar to spermatogonia. A mature ovum develops about every 28 days, which coincides with ovulation. The mature ovum has half, or 23, of the normal complement of 46 chromosomes.

Menstrual cycle

Menstruation is the periodic sloughing off of the lining of the uterus. The cycle is regulated by rhythmic changes in estrogen levels.

Onset (menarche) is at puberty, usually between ages 11 to 15 years. It ends at menopause approximately 40 years later. The first day of menstrual flow is the first day of the cycle. The full cycle is 28 days long on the average.

At the beginning of the cycle, several ova start to grow and develop. After approximately 1 week, all but one degenerate. Simultaneously, the old lining of the uterus is sloughed causing menstrual flow. This sloughing is completed by the fifth day. The remaining ovum continues to grow until around day 14 when it literally “explodes” (ovulation) from the ovary and is drawn into the fallopian tube, where it travels into the uterus.

During this time, the uterine lining has been thickening and rebuilding in preparation for a fertilized ovum. If there is none, the lining is shed and the cycle starts anew.

Menstruation can enhance the spread of certain sexually transmitted diseases from the vagina into the uterus, oviducts, and abdomen.

Physiology of fertilization

Although only one sperm fertilizes an ovum or egg, many sperm are necessary to “peck away” the layer of protective cells surrounding the ovum. Because of this, and because so many sperm are lost along their journey through the female reproductive tract, unless a man’s semen contains upwards of 20 million sperm cells per milliliter, the man may be considered sterile. Sperm cells can survive in the female tract for 24 to 72 hours and fertilize the egg, which is normally ovulated on the 14th day of the 28-day menstrual cycle. Fertilization occurs in the fallopian tube, and the fertilized ovum or zygote then moves into the uterus where it will freely migrate for approximately 10 days.

Embryology

Once the embryo attaches to the placenta in the uterine lining, blood exchanges between the fetus and mother. This blood, flowing through the fetal umbilical cord, takes nutrients, like food and oxygen, to the embryo and carries away waste products, like carbon dioxide. Thus,

whatever is contained within the mother's bloodstream will soon pass into the fetal bloodstream. These materials can be life sustaining or life threatening to the fetus depending on their source. Certain chemicals or other agents present in the workplace can be very hazardous to the developing fetus, especially during first 3 months of development (first trimester). During the first trimester, all the major body systems are developing and are thus very susceptible to developmental abnormalities. For example, only 4 weeks after conception, the fetal heart is pumping blood, the spinal cord and digestive system are forming, and arm and leg buds are present. By 8 weeks of age, the facial features are forming, the arms and legs are developed, and fingers and toes are forming. At the end of the first trimester or 12 weeks, the fetus is 3 inches long and all the major body systems have developed. From this point on in the pregnancy, the likelihood of major malformations drops off rapidly. What are some of the factors that place the fetus at risk?

Adverse influences

Adverse influences on the fetus or fertility can usually be grouped into one of four categories—teratogens, mutagens, carcinogens and gametotoxins.

Adverse Influence	Explanation
Teratogen	Is a substance that causes physical defects in the developing embryo.
Mutagens	Disrupt the cell's DNA resulting in a genetic defect. In addition, because the DNA carries the genetic information from parent to child, these defects may be inherited by future generations.
Carcinogens	Are substances capable of causing cancer. If the mother is exposed to carcinogens while she is pregnant, not only may she develop cancer later in life, but the child exposed while in the womb may also develop cancer much later. For example, radiation exposure may later result in leukemia.
Gametotoxins	Either reduce the number or the function of the gametes, the sperm, or ova. As we have already seen, a reduction in the number of sperm, even though millions are still present, can render a man functionally sterile. If the gametes do not function normally, this, too, can result in sterility (e.g., exposure to a gametotoxin can affect the function of the sperm's tail). If the tail does not work normally, the sperm cannot fertilize the egg and sterility results.

These concepts of fertilization, embryology, and the adverse influences in our environment that can affect the fetus provide the background for the fetal protection program you'll study later.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

013. Digestive system

1. What are the three functions of the digestive tract?

2. What are the two main elements of the digestive system?

3. How is food moved through the digestive tract to the stomach?

4. What are the finger-like protrusions called that line the small intestine?

5. What portion of the digestive tract serves to store fecal material until expelled?

6. What salivary glands are the primary target for the mumps virus?

7. Which organ produces blood clotting factors and detoxifies certain chemicals?

8. High levels of bilirubin in the bloodstream cause what condition?

014. Urogenital system

1. How much urine leaves the kidney from 125 ml of filtrate production?

2. What is indicated when the kidneys are forming very concentrated urine?

3. What is an external pendulous sac that contains the epididymis?

4. What is the function of the epididymis?

5. What is the primary male hormone?

6. What are some examples of secondary male characteristics?

7. What structures produce female hormones estrogen and progesterone?

8. Which female hormone is responsible for repairing the uterine lining after menstruation?

9. What is oogenesis?

10. How long can the sperm cells survive in the female tract and fertilize the egg?

11. What substances reduce the number of sperm or ova?

3–4. Endocrine and Nervous Systems

The endocrine and nervous systems function as the body's internal communication system. The endocrine system acts by releasing hormones into the bloodstream. These hormones can then act on only certain cells or on virtually every cell in the body. The nervous system functions through a complex network of incoming and outgoing nerve tracts that pick up sensations, control muscles, and enable thoughts and memory.

015. Endocrine system

Before you look at some specific endocrine glands, first see what hormones are and how their secretion is regulated.

Hormones and feedback systems

Hormones are chemical substances secreted into body fluids, usually the bloodstream, and they exert physiologic control on other cells of the body. Their secretion is controlled by a process known as negative feedback. In this process the *absence* of a stimulus causes a *greater* response. Put another way, the presence of a stimulus causes a shutdown of the response. A good example of this negative feedback system is illustrated in the interaction between the pituitary gland and the thyroid gland (fig. 3–11). One of the hormones produced by the pituitary gland is thyroid stimulating hormone (TSH). TSH causes the thyroid to produce the hormone thyroxine. When the thyroid has produced enough thyroxine, the pituitary stops releasing TSH and the thyroid stops producing more thyroxine. As you can see so far, the presence of the stimulus (in this case thyroxine) caused a shutdown of the response (pituitary release of TSH). However, as thyroxine levels begin to drop again, the pituitary senses the low thyroxine level and releases TSH, which in turn stimulates the thyroid to release thyroxine. In this case, the absence of the stimulus caused a greater response. This cycle goes on continually and is a good example of the way hormone levels are finely tuned by negative feedback systems.

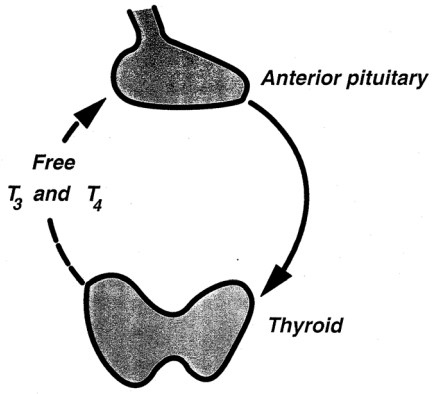


Figure 3–11. Negative feedback system (pituitary gland and thyroid gland).

You've learned a little about the pituitary gland and its interaction with the thyroid gland. Now look a little more at the pituitary gland, the master gland.

Pituitary gland

The pituitary, located within the skull at the base of the brain, is called the master gland because it controls the secretions of so many other endocrine glands. In fact, the pituitary gland secretes eight different hormones:

Hormone	Explanation
Thyroid stimulating hormone	Controls the secretion of thyroxine from the thyroid gland.
Prolactin	Promotes mammary gland development and milk production in the female.
Corticotropin	Influences the adrenal glands.
Follicle stimulating hormone and lutenizing hormone	Both influence the gonads (reproductive organs) in the male and the female.
Antidiuretic hormone	Controls the amount of water excreted by the kidney into the urine.
Oxytocin	Promotes milk let down and uterine contractions.
Growth hormone	Causes growth of all body tissues. If insufficient amounts of growth hormone are secreted during childhood, the affected individual is called a dwarf. In contrast, if too much is secreted during childhood, the individual may reach a height of 8 or 9 feet and is called a giant. Even after adulthood, a small amount of growth hormone secreted by the pituitary gland is necessary for a normal healthy state.

Thyroid gland

The thyroid gland, located immediately below the larynx, secretes the hormone thyroxine. Iodine is necessary for the thyroid's production of thyroxine; many people use iodized salt to ensure they eat adequate amounts of this important element. The disease, known as goiter, characterized by swelling of the thyroid gland, can result from a dietary deficiency of iodine. Normal amounts of thyroxine are essential to maintain a normal basal metabolic rate. If too much thyroxine is produced, the person becomes excitable and nervous and exhibits a rapid pulse, and in some cases, the eyes protrude slightly. This condition is called hyperthyroidism. If too little thyroxine is produced, the person always feels cold, has no energy, and is mentally sluggish. This condition is known as hypothyroidism.

Adrenal glands

Located just above the kidneys, the adrenal glands are really two separate organs joined as one, but very different in structure and function. The outer layer, or cortex, is absolutely essential to life. Its secretions influence salt absorption by the kidneys and the metabolism of sugars. The inner layer or adrenal medulla produces epinephrine and norepinephrine (sometimes called adrenaline and noradrenalin). These are responsible for the body's "fight or flight" response. They cause the body to mobilize energy and strength in response to a life-threatening situation.

Testes and ovaries

The ovaries in the female and the testes in the male are influenced by the pituitary hormones luteinizing hormone (LH) and follicle stimulating hormone (FSH). In the male, FSH regulates sperm production while LH controls secretion of the male hormone, testosterone. In the female, the ovaries secrete two different hormones, estrogen and progesterone. Estrogen causes the development of the secondary sex characteristics at puberty, and progesterone is necessary for implantation and to maintain the state of pregnancy during fetal development.

Pancreas

Although the pancreas has an exocrine function, as mentioned in the discussion of the digestive system, it also has an important endocrine function. The pancreas secretes two hormones, insulin and glucagon, which have essentially opposite functions. Insulin enables all body tissues to metabolize sugar circulating in the bloodstream, thus lowering blood sugar level. The lack of insulin causes a disease called diabetes mellitus. In the diabetic, since insufficient insulin is produced to enable cells to metabolize the blood sugar, the level of sugar in the blood rises to extremely high levels. Diabetes can usually be managed by a regulated diet and, in some cases, insulin injections. Glucagon increases blood sugar levels when they are too low.

016. Nervous system

You've just finished studying one of the body's internal communications systems, the endocrine system. Now, take a look at another, which acts even more quickly. The nervous system is composed of over 10 billion individual nerve cells (neurons), but no matter where in the nervous system they are located, they all have the same basic structure.

Anatomy of a neuron

The anatomy of neurons enables them to perform their primary function, conducting electrical impulses from one part of the body to another. All neurons consist of a cell body and two types of protrusions or processes. These processes are the axons and dendrites (fig. 3–12). Axons carry the impulses *away* from the cell body, while dendrites carry impulses *toward* the cell body. Although neurons are similar in anatomy and physiology, the nervous system is divided into the central nervous system (CNS) and the peripheral nervous system (PNS).

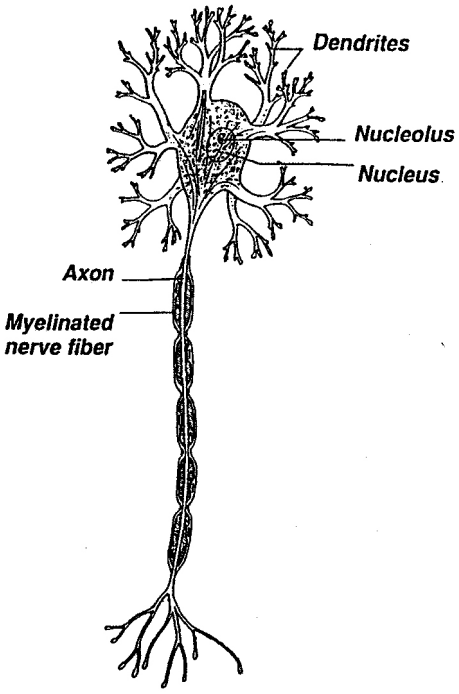


Figure 3–12. Axons and dendrites in a neuron.

Central and peripheral nervous systems

The central nervous system is made up of the brain and spinal cord and contains both gray and white matter. Gray matter is gray in color because it contains so many cell bodies. White matter derives its color from the nerve fibers and the insulating myelin coatings they contain. Much of the gray matter is found in the cerebrum, which accounts for $^{7}/_{8}$ of our total brain weight. The cerebrum is divided into frontal, parietal, temporal, and occipital lobes and accounts for our ability to speak, think, and function at higher levels than other animals. The spinal cord contains nerve tracts running to and from the brain and, thus, is largely made of white matter. The brain and spinal cord are well protected by several structures. First, they are well protected by bone. The skull protects the brain, and the bony vertebral column provides excellent protection for the spinal cord. Beneath this bony protection, the meninges also cover the brain and spinal cord protecting them. The meninges are multilayered membranous coverings. When they are inflamed by infectious agents, such as viruses, bacteria, and fungi, the condition is called meningitis. Finally, within and around the brain and spinal cord, cerebrospinal fluid (CSF)

provides a protective waterjacket that functions as an excellent shock absorber. CSF can be withdrawn and analyzed; its composition can provide important diagnostic information during illness.

The CNS is a marvelous computer integrating all kinds of different information, but there must be a system to bring information to the CNS and then carry the orders of the CNS to their site of action. That system is the peripheral nervous system. The sensory nerves carry the information gathered from different sense organs to the CNS where it is acted upon or integrated. These sensory sensations may be pain, temperature, or electromagnetic (light) to name a few. After the CNS receives the information, some type of response may be indicated. These responses are most commonly a muscular contraction or a gland's secretion. The nerves that carry these impulses to the muscle or gland are called motor nerves. These motor nerves may be either voluntarily controlled or involuntary motor nerves. We have no conscious control over involuntary motor nerves. For example, the contractions of our small intestine, the dilation of blood vessels, and the production of sweat by the sweat glands are involuntary actions. Injury to a nerve of the PNS may leave part of the body without sensation and control by the CNS nervous system. Regardless of what part of the nervous system we are talking about though, the method by which nerves carry impulses is the same.

Nerve conduction

Impulses travel *electrically within* a single nerve and travel by *chemical* means when crossing *from one nerve to the next*. In electrical transmission a nerve impulse travels down an axon because the electrical voltage within the nerve changes from negative to positive. This advancing electrical discharge carries the impulse down the length of the nerve until it reaches the synapse. The synapse is a small cleft or space between nerve cells. The electrical voltage reversal cannot cross this gap, but chemicals can (fig. 3–13). When the electrical impulse arrives at the end of the axon, a chemical is released that crosses the synapse. When this chemical reaches the next neuron, it sets up the same reversal of electrical voltage, and the impulse then moves down that neuron electrically. The chemical that crosses the synapse and enables the impulse to move from one neuron to the next is called a neurotransmitter. One very common neurotransmitter is acetylcholine. Botulism toxin exerts its effects by inhibiting the release of acetylcholine, thus blocking the conduction of impulses from one nerve to the next. Absence of acetylcholine can lead to paralysis and death. Too much of a good thing, though, in this case acetylcholine, is not good either. Once the acetylcholine is released into the synapse, it continues to stimulate the neurons as long as it is present. There must be some way of removing it once it has served its purpose; otherwise, once stimulated by acetylcholine, the nerve might continue to discharge for hours. Acetylcholine is removed from the synapse by an enzyme, acetylcholinesterase. This chemical prevents acetylcholine from accumulating in the synapse and causing repeated nerve stimulation.

Understanding the physiology of nerve conduction simplifies understanding the toxicology of different nerve agents used in warfare as well as the organophosphate pesticides commonly used on Air Force installations. These poisons interfere with the activity of acetylcholinesterase. If this enzyme is nonfunctional, acetylcholine in the synapse is not inactivated, and once released, the acetylcholine continues to stimulate the nerve or muscle. In man, this poisoning causes pinpoint pupils, salivation, diarrhea, and can be fatal.

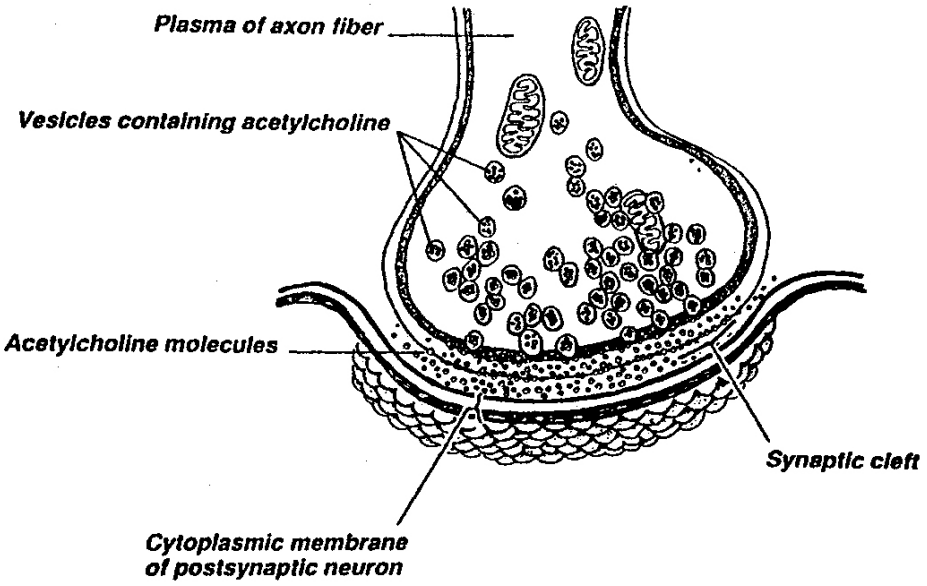


Figure 3–13. Electrical and chemical activity in a synapse.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

015. Endocrine system

1. What process controls the secretion of hormones?

2. What organ produces growth hormone?

3. What is the condition that produces too much thyroxine, where the person becomes excitable, nervous, exhibits a rapid pulse, and in some cases the eyes protrude slightly?

4. Which organ produces epinephrine (adrenaline)?

5. What hormone in males controls secretion of the male hormone testosterone?

6. What is the function of insulin in the body?

016. Nervous system

1. What structure of a neuron carries impulses away from the cell body?

2. What are the two divisions of the nervous system?

3. What are the two parts to the central nervous system?

4. Name the four lobes in the cerebrum.

5. What is a multilayered protective membranous covering around the spinal cord underneath the bony protection?

6. Which nerves carry impulses to a muscle or gland?

7. What chemical crosses the synapse of a neuron to enable an electrical impulse to move from one neuron to the next?

8. Which substance stops the chemical stimulation action in the neuron?

3–5. Sensory Systems

We gather information about the world we live in with our sensory systems. The importance of this input is put into its proper perspective when one realizes that those experimentally deprived of all sensory input begin to hallucinate in only a few hours. Any sensation you can imagine will occur if only four requirements are met. First, a stimulus must be present. This stimulus, a physical event, may be a light or sound wave, a change in temperature, a painful stimulus, or something else. Second, you must have a receptor capable of responding to the stimulus and of changing the physical event into a set of nerve impulses. The receptor can be a hair cell in the inner ear, a rod or cone in the retina of the eye, or another receptor specially adapted to receive special stimuli. Third, there must be a conducting pathway from the receptor to the CNS. This pathway is found in the PNS. Fourth, the CNS must interpret the impulses and bring about a conscious sensation of the stimulus. You'll now study the three major sensory systems: skin, eyes, and ears.

017. Human skin

The skin is the largest organ of the body and has four primary functions. The skin's receptors sense pain, touch, temperature, and pressure The skin also serves a protective function by protecting the underlying tissues from harmful chemical, physical, and biological agents, and inhibiting the excessive loss of water and electrolytes. The third function of the skin is that of secreting sebum from sebaceous glands and sweat from sweat glands. The last function performed by the skin is that of temperature regulation.

Temperature regulation

The skin helps regulate the internal temperature of the body by adjusting its blood flow and by sweating. Take a look first at how a change in blood flow to the skin can affect body temperature. When the body is hot, the vessels in the skin can dilate and accept up to seven times the normal amount of blood. Heat in the blood can then be efficiently radiated from the skin to the surroundings like a car radiator. On the other hand, when the body is cold and needs to conserve heat, blood flow to the skin is restricted. It may be so restricted that it actually slows fingernail growth due to inadequate circulation and nutrition of the nail bed. This system of heat radiation is effective only when the surroundings are cooler than the body. Once the ambient temperature rises above body temperature, this mechanism is no longer effective. In fact, heat is actually radiated to the body from the hot environment. At this point, the other method of heat regulation, sweating, must take over. As the sweat evaporates off the skin surface, a considerable amount of heat is lost in the process. When the humidity in the air is high, evaporation is less effective and the heat seems more oppressive. Under very hot conditions, a person can sweat up to 4 liters per hour. Not only is a lot of fluid lost, but also tremendous amounts of electrolytes (salts). These substances must be replenished or serious metabolic problems can occur.

Before leaving the coverage of the human skin, you should learn some of the most common types of skin lesions.

Common lesions

When studying tuberculosis skin tests and the symptoms associated with different communicable diseases, you'll hear these medical terms tossed around.

Term	Definition
Dermatitis	Inflammation of the skin.
Erythema	Reddening of the skin.
Induration	Swelling.
Pustule	A blister filled with pus.
Vesicle	A blister or elevation filled with fluid, not pus.
Ulcer	An erosion of the skin surface.
Papule	Reddened, solid elevation of the skin.
Macule	A reddened, flat spot on the skin.

A good understanding of these terms will be very useful in your dealings with patients and other medical personnel.

018. Eyes and ears

The eye is a receptor capable of responding to a very narrow frequency band within the electromagnetic spectrum. This narrow frequency band is called visible light.

Anatomy of the eye

The sclera is the white protective layer on the outside of the eyeball (fig. 3–14). It is continuous with the cornea, which is the clear protective layer on the front of the eyeball. Within the eyeball, the iris, or colored part of the eye, dilates and constricts depending on the amount of available light, allowing the light rays to pass through an opening, the pupil, on into the deeper parts of the eye. Light then passes through the lens, which focuses the light onto the back surface of the eye, the retina. The retina contains the receptor cells known as the rods and cones, which are capable of changing a physical event (light rays entering the eye) into a nerve impulse that is then carried to and interpreted by the brain as vision. This is the normal course of events. However, changes in the shape and structure of these organs can cause visual abnormalities.

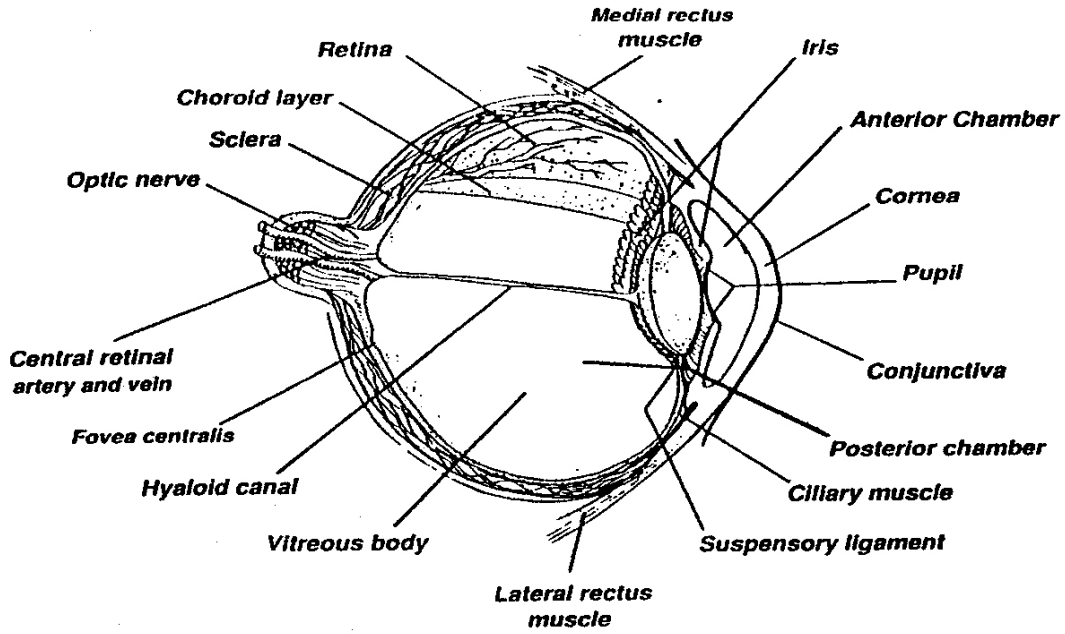


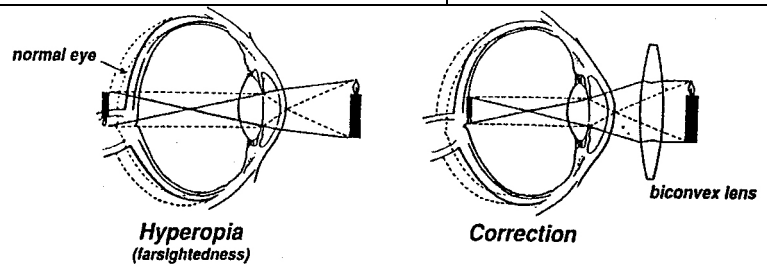
Figure 3–14. Anatomy of the eye.

Visual abnormalities

Condition	Cause	Correction
Myopia (nearsightedness)	Caused by an eyeball that is too long. Instead of the image clearly focusing on the retina, it is focused in front of the retina and blurred by the time it reaches the retina.	**A biconcave lens will diverge the incoming light rays so they will be clearly focused on, not in front of, the retina (fig. 3–15).**

Figure 3–15. Biconcave lens used to correct myopia.

Condition	Cause	Correction

Hyperopia (farsightedness)	The opposite situation exists when someone has hyperopia or farsightedness. In this case, the eyeball is too short and the image has not had a chance to be focused by the time it strikes the retina.	A biconvex lens will converge the incoming light rays so they will be clearly focused on, not in back of, the retina (fig. 3–16).
	 **Figure 3–16. Biconvex lens used to correct hyperopia.**	
Astigmatism	Someone with an astigmatism has a cornea or lens that is not evenly curved resulting in a distortion of the image.	A specially shaped corrective lens can counteract the image distortion. The lens of the eye is normally clear allowing unobstructed passage of light to the retina.
Cataracts	Cataracts occur when the lens becomes cloudy, thus restricting vision.	In some cases, vision is improved by removing the clouded lens.
Color blindness	The most common type of color blindness is red-green color blindness. In this condition, either the red-sensitive or green-sensitive cones are missing, so the person cannot perceive the difference in these colors, and both appear the same.	There is no correction for color blindenss.

The last sensory system we cover is the ear. The ear involves two major sensory functions, hearing and equilibrium. We cover hearing first and begin with a look at the anatomy of the ear.

Anatomy of the ear

The ear is usually covered in three anatomical divisions—outer ear, middle ear, and inner ear (fig. 3–17). The outer ear is made up of the auricle, which collects sound waves and conducts them down the ear canal to the tympanic membrane (eardrum). The middle ear begins at the eardrum and includes three ossicles, or small bones, that detect movement of the eardrum and transmit these movements on into the inner ear. The eustachian, or auditory, tube also enters the middle ear from the pharynx and is important for equalizing pressure between the middle ear and the outside environment. The inner ear contains the cochlea, or end-organ of hearing, and the semicircular canals, or organ of equilibrium. How do all of these parts work together? Take a look at sound perception first.

Sound perception

Sound waves traveling through the air are gathered by the auricle and conducted down the external ear canal where they hit the eardrum and cause it to vibrate. (See fig. 3–17 for technical names and fig. 3–18 for functions.) These vibrations are transmitted through the ossicles of the middle ear to the fluid-filled cochlea. The cochlea is lined by many small hair cells. These cells, as the name implies, are tipped by a small hair that protrudes up into the fluid within the cochlea. As fluid waves created by the pressure of the vibrating ossicles move through the cochlea, the hairs on the hair cells are disturbed and generate a nervous impulse based on this stimulation. We detect the origin of sounds by comparing the intensity

in one ear with the intensity in the other. Deafness can be caused by auditory nerve or cochlea damage. Excessive noise can damage the delicate hair cells in the cochlea. This damage is preventable and irreversible and is the focus of the Hearing Conservation Program.

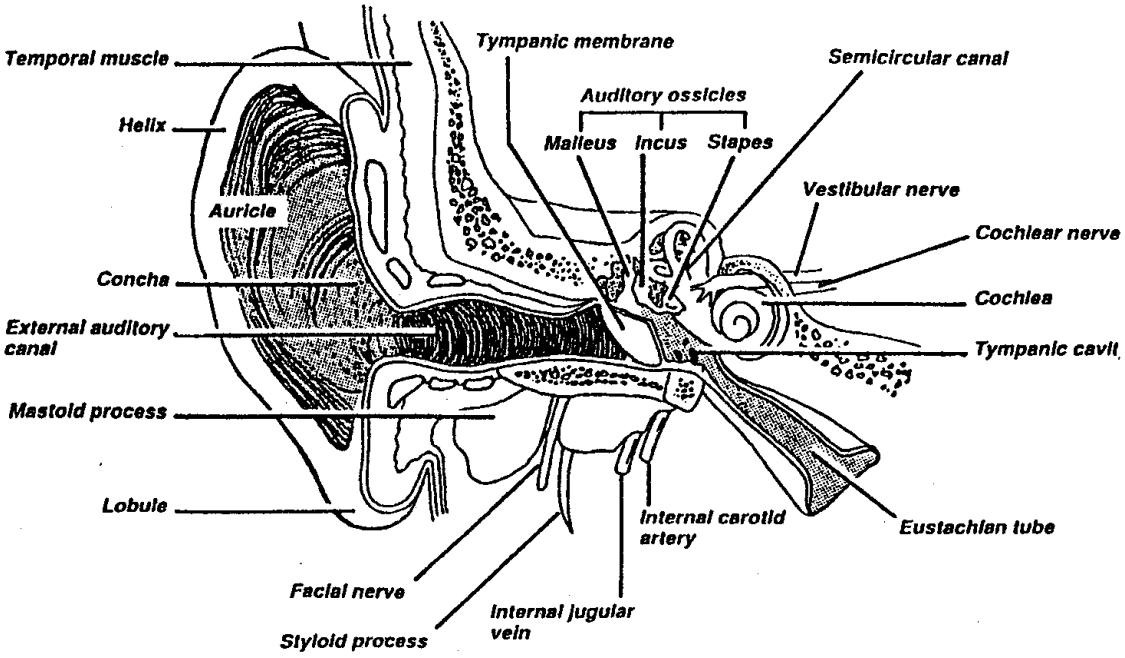


Figure 3–17. Anatomy of the ear.

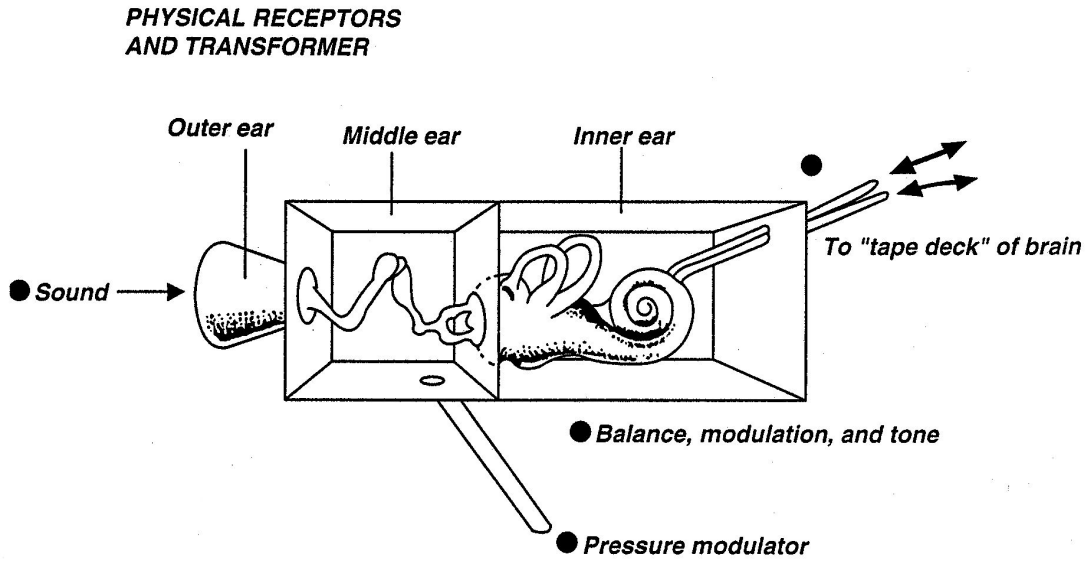


Figure 3–18. How we hear.

Equilibrium

Equilibrium is controlled by the semicircular canals and related structures. There are three fluid-filled semicircular canals—one in each plane at right angles to each other—in each

inner ear. When the body moves, the fluid inside the canals moves and stimulates receptor cells. Another closely related system is sensitive to the pull of gravity and indicates, via nerve impulses, the body's position relative to the pull of gravity. These equilibrium systems can be fooled when a person undergoes vertigo or a state of dizziness or confusion. Pilots are taught to trust their instruments rather than to "fly by the seat of their pants," because what feels right may actually be wrong.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

017. Human skin

1. What are the four main functions of the skin?

2. Under very hot conditions, how much sweat can a person lose?

3. What does erythema mean?

4. What is meant by vesicle?

5. What is a papule?

018. Eyes and ears

1. What is the white protective layer on the outside of the eyeball called?

2. What portion of the eye contains the receptor cells known as rods and cones?

3. What is another name for nearsightedness?

4. What type of lens is used to correct farsightedness?

5. What part of the ear enters the middle ear from the pharynx and is important for equalizing pressure between the middle ear and the outside environment?

6. What are the two sensory functions of the ear?

7. What is another name for the state of dizziness or confusion?

3–6. Basic Principles of Immunology

The earliest recognition of the immune phenomenon was associated with smallpox. Thousands died as a result of this and other deadly diseases. Nevertheless, the fact that those who had recovered from an attack of smallpox did not become reinfected led Orientals to practice self-inoculation with smallpox matter. As you may recall, it was Jenner who undertook an exact approach to vaccination by vaccinating people with cowpox.

This section is concerned with an infected person's defense mechanisms against an infectious agent. This requires an understanding of natural and acquired defenses and the laboratory tests used to monitor a patient's response. Your study of immunity is important in aiding the health care provider in the diagnosis and treatment of infectious diseases and contributes directly to your successful management of communicable disease programs.

019. Mechanics of immunity

When a person comes in contact with microbes that cause an infectious disease, the body responds in an attempt to counteract the effect of the disease-producing agents. If the response is such as to provide partial or complete protection, then that person is said to have a certain degree of immunity. Immunity, which may be either natural or acquired, is the subject matter of the science of immunology.

Natural resistance

When we speak of natural resistance to disease, we are referring to immunity dependent on some special anatomical or physiological property of an animal species rather than to a specific antibody. For instance, the fact that we are human gives us a certain nonsusceptibility that is different from that of dogs, cats, or other lower animals. On the other hand, many animals have a natural resistance quite different from that of humans. We know, for example, that foot-and-mouth disease rarely affects man, but it produces a possible fatal infection in cattle, sheep, and goats. Hepatitis B virus and syphilis are diseases unique to humans. Tuberculosis is common in humans, cattle, pigs, and chickens, but it is uncommon in sheep, cats, dogs, and horses.

Many defense mechanisms are active in natural resistance. Although there is much overlapping, these defense mechanisms can be divided into two categories, anatomical and chemical. Examples of anatomical mechanisms include the physical barrier of the intact skin, which prevents disease organisms from entering the body; white blood cells, called phagocytes, which actively engulf (phagocytize) foreign substances; and the sweeping action of the cilia in the respiratory tract, which physically removes disease agents. Examples of chemical natural defense mechanisms include lysozyme, an enzyme present in many body fluids, that attacks bacteria; interferon, a substance the body produces to fight viral infections; and the highly acidic pH of the stomach that destroys most microbes.

Acquired immunity

This type of immunity develops before birth and throughout the lifetime of the individual. A baby passively receives protective immune substances from the mother's blood during fetal development and, after birth, in breast milk. Exposure to organisms after birth often results in the development of active immunity. There are important differences between these two types of acquired immunity.

Passive immunity

Passive immunity is a type of acquired immunity because antibodies are involved. It differs from active immunity by the fact that the antibodies produced by another person are passed on to the recipient. The recipient receives the immunity from these "borrowed" antibodies, but is not actively producing them. Passively transferred antibodies are important to the recipient because they give *immediate* protection. However, since they are gradually destroyed by the body, this protection decreases, and the recipient eventually becomes susceptible to reinfection. Passive immunity can be acquired both naturally and artificially.

Naturally acquired passive immunity

This type of immunity is significant mainly in the survival of newborn infants. Infants passively acquire antibodies from their mothers. The antibodies may pass from the immune mothers to the fetuses across the placental barrier. Additionally, infants acquire these antibodies from their mothers' milk, which is rich in antibodies for a short time after birth. Of course, immunity is transferred only if a mother is immune to a given disease. Passive immunity is especially important to newborns because they are incapable of producing antibodies of their own for a few months after birth. The antibodies received via natural transfer from the mother are relatively short-lived, with protection seldom exceeding 6 months. Fortunately, by this time the infant's immune system is fully functional.

Artificially acquired passive immunity

Antibodies that were produced in one person and injected into another (the recipient) provide this type of immunity. This method is used for prophylaxis following exposure to such diseases as rubella and as antitoxins against tetanus, botulism, and snake venoms. Passive immunization is also used in conjunction with active immunization to provide immediate, temporary protection against diseases such as rabies and hepatitis B until the body can produce its own antibodies.

Active immunity

Active immunity is another type of acquired immunity because it involves specific antibodies against a foreign substance. It is called active immunity because the body actively produces antibodies in response to an exposure of an agent. This exposure may be from an infection or in response to vaccinations.

Active immunity is not always perfect and can be graded into a series of levels that extend from complete immunity to a state approaching complete susceptibility. Since the body's defenses can often be overcome if the challenging dose of microbes is large enough, several grades of illness can occur between the two extremes. Antibodies may or may not contribute to immunity; for example, an individual mcanay produce antibodies to human immunodeficiency virus (HIV) that have no apparent protective value at all, but their detection may be useful in diagnosis.

Naturally acquired active immunity

When a person is infected with a specific disease organism, antibodies develop, and the person is resistant to reinfection by the organism. The result of natural infection is active production of antibodies, which provides naturally acquired active immunity. In many diseases, such as smallpox, mumps, measles, and chickenpox, infection and resulting antibody production results in permanent immunity. However, this is not always the case in other infections. For example, influenza and gonorrhea result in very short-lived immunity and repeated attacks are common.

Artificially acquired active immunity

For many diseases, vaccination has proven to be an effective method of providing immunity. Antibodies are actively produced in the body in response to vaccination, an artificial infection. This immunity is not absolute and the ability of vaccines to provide long-term protection varies considerably. For example, plague vaccine must be given every 6 months for protection, but yellow fever shots every 10 years. Obviously, the yellow fever vaccine is much more effective than plague vaccine.

An example of the use of active and passive immunization is the use of rabies vaccine and immune globulin. Rabies is a viral disease and 100 percent of those infected die if not vaccinated. Since humans rarely have any naturally acquired immunity to rabies, an unvaccinated person exposed to the disease would have to rely solely on artificially acquired immunity. Rabies immune globulin would be given to provide immediate short-term protection (passive immunity). Rabies vaccine would also be used to stimulate the person's antibody production (active immunity) to provide long-term protection. Susceptible or nonimmune individuals exposed to hepatitis B virus are treated in a similar fashion. Hepatitis B immune globulin (HBIG) provides immediate, temporary protection, and hepatitis vaccine stimulates active production of antibodies for long-term protection.

020. Serology

The diagnosis of disease by detection of antibodies in the blood (serum) is called serology. Serology plays an important role in our communicable disease control programs. Frequently, serology is the only practical means of diagnosing a given disease. Perhaps isolation of the causative agent would be impossible, too expensive, or take too long to benefit the patient. We use serology in our sexually transmitted disease program to identify syphilis infections, discriminate between hepatitis A and hepatitis B viral infections, and determine the susceptibility of hospital employees to rubella (German measles) and rubeola (measles). Serology can also be used for the detection of other substances such as hormones to diagnose noninfectious conditions. Pregnancy is diagnosed using serology.

Antibodies

Especially significant to the health care provider and you in the diagnosis of infectious disease is the level of antibody or titer produced during the course of a disease. The presence of antibodies can indicate either a past (old) or current (active) infection. The presence of antibodies can also indicate the individual was vaccinated against a particular disease.

In most cases, serology cannot determine whether antibodies are the result of infection or vaccination. In most diseases, the titer (antibody level) increases in response to an active infection. A person may be considered actively infected if the titer rises or if it reaches a certain level, such as fourfold the normal level. To detect a rise in antibody level, you must take at least two blood samples, the first early in the disease (acute), and the second during recovery (convalescent) several days or weeks later.

After the infection is controlled or eliminated, the titer gradually falls. Frequently, the antibody may still be detected, but this does not mean the person has an active or current infection. Rather, it is an indication of past infection. As an example, someone may have a low antibody titer to influenza virus, indicating an immunity from a previous infection. The same person would be considered actively infected if the titer showed an increase over 2 to 3 weeks or the titer was high (four-fold normal) in a single sample.

Antigen-antibody interaction

Much is known today about antigens, antibodies, and their interactions. To understand how the body fights infection, you must first learn the characteristics of antigens and antibodies.

Antigens

Any foreign substance that stimulates the body to produce an immune response is called an antigen. An antigen might be a microbe, part of a microbe, a microbial toxin, or even some foreign product completely unrelated to microorganisms such as pollen. In general, an antigen is anything the body recognizes as foreign or "not self." Antigens stimulate the formation of specific antibodies, and these antibodies must react with the antigen in some observable way.

Antibodies

Antibodies are found in the globulin fraction of serum proteins. More specifically, most antibody activity is in the gamma globulin fraction of serum globulin. Thus, antibodies are frequently called immunoglobulins.

Just as antigens are defined in terms of their reactivity with antibodies, all antibodies are intimately associated with their antigens. These antibodies must be able to react in some demonstrable way with the antigen, which stimulated their production. In general, each antibody will react only with the antigen that stimulated the body to produce that antibody. In other words, each antibody possesses a high degree of specificity, although there are some exceptions to the rule.

Immunoglobulins

The immunoglobulins (antibodies) of man can be further categorized into five main classes: (1) IgG, (2) IgM, (3) IgD, (4) IgA, and (5) IgE. Most antibody activity is due to IgG, IgM, or IgA, with certain diseases causing the production of more of one class than another. Additionally, the class that is produced in greatest quantity varies with the number of times the individual has been exposed to a particular antigen. Usually, on the first contact, such as vaccination, IgM is the main antibody produced, but on subsequent contacts, IgG usually predominates. The five classes of antibodies vary somewhat in their functions, as explained in the table on the next page.

Antibody	Explanation

IgG	Is the most abundant class, comprising about 75 percent of the total serum immunoglobulins. IgG is the only antibody small enough to cross the placenta in the immune mother, thus protecting the newborn child. IgG antibodies neutralize toxins and viruses in the bloodstream and in tissues. IgG is usually the antibody involved in secondary response to infection and immunization, and is most often detected later than IgM in initial infections.
IgM	Constitutes 6 to 8 percent of the serum antibodies, but is very important because it's usually the first antibody to respond to infection. IgM antibody is 700 to 1,000 times more affective than IgG in neutralizing bacteria because it is the largest of the immunoglobulins and has many antigen-antibody reaction sites.
IgA	Occupies a unique position among the immunoglobulins in that it is found in body secretions in addition to comprising about 20 percent of the serum immunoglobulins. IgA occurs in large amounts in tears, colostrum, saliva, mucus, and other internal secretions, and provides immune response to pathogens that enter by the respiratory or gastrointestinal tracts.
IgD and IgE	Are found in very small amounts in the serum. IgE is responsible for allergic responses and believed to be important in the activation of B cells.

021. Immune system cells and tissues

The immune system encompasses the whole body, but the lymphoid system is the site and source of most immune activity. This system is composed of organs, tissues, and cells that constantly combat any infectious agent that tries to invade the body. The lymphoid system is also called the reticuloendothelial system. Additionally, lymphatic system structures, such as lymph vessels and lymph nodes, serve as the site for removal of most large foreign agents such as bacteria.

The lymphoid system

The lymphoid or reticuloendothelial system involves organs and tissues where lymphocytic cells originate, mature, and differentiate or specialize. Once mature, the lymphoid cells either lodge in the lymphoid organs or move throughout the body.

Lymphoid organs

The bone marrow, spleen, thymus, and lymph nodes are organs where the cells of the immune system develop, mature, and differentiate.

Lymphoid cells

The lymphocyte is the cell that protects the body from infection once a foreign agent has entered. All lymphocytes come from stem cells formed in the bone marrow. However, during the maturing process, lymphocytes differentiate into B-lymphocytes and T-lymphocytes, also called B- and T-cells. Both are very important in immunity, but they respond to infection in very different ways.

B-lymphocytes

The B-lymphocyte is the basis for humoral immunity, that is, immunity involving antibodies. When a B-cell detects an antigen, it further differentiates into a plasma cell or a memory cell. The plasma cell produces antibodies against the antigen. The memory cell waits until a later time when the same specific antigen enters the system.

T-cells

T-lymphocytes are the basis for cellular immunity and do *not* produce antibodies. Instead, they produce a number of chemicals that recruit other cells, such as B-cells and phagocytes, in the immune response. T-cells further differentiate, for example, into killer, helper, and memory cells. Killer T-cells have a special function in detecting and destroying abnormal

(not self) cells such as tissue grafts, tissue damaged by radiation or chemicals, bacteria, viruses and tumor cells. T-cells also destroy cells of the body (self) that have been made abnormal by infectious agents such as bacteria, viruses, fungi, protozoa or worms. To illustrate the importance of the T-cell, the HIV infects and destroys the T(helper)-cell. When a sufficient number of helper cells are destroyed, the individual immune cells can not respond effectively, and the individual develops acquired immunodeficiency syndrome (AIDS). Additionally, the T-cell is responsible for coordinating the positive tuberculosis skin test reaction in persons previously exposed to the tuberculosis organism.

Structures of the lymphatic system

The lymphatic system is a drainage system that collects fluid from interstitial (intercellular) spaces and returns it to the cardiovascular circulation of the body. This is part of the fluid regulation cycle in which fluid leaves the blood, goes into the intercellular spaces, and returns to the bloodstream via the lymphatics (lymph vessels). Lymph is similar to plasma, the fluid portion of blood. The structures of the lymphatic system include lymph capillaries, lymph vessels, lymphatic ducts, and lymph nodes.

Lymph capillaries

Lymph capillaries are the smallest of the system. They are microscopic and blind-ended. They branch throughout the intercellular space and collect lymph. The capillaries eventually come together to form a vessel.

Lymph vessels

Lymph vessels are similar to veins and collect the lymph from the capillaries. Physiologically, lymph vessels are very similar to veins. They have one-way valves located within them and have very low pressure. The one-way valves keep the lymph flowing toward the lymphatic ducts. Flow through these valves is possible for several reasons. Lymph is propelled by skeletal muscle action and natural artery pulsation. Pressure changes within the thorax and smooth muscle contraction in vessel walls also force lymph through vessels. Finally, the formation of new lymph pushes the old forward toward the ducts.

Lymphatic ducts

Lymph vessels empty into two main trunks. The largest is called the thoracic duct, which collects fluid from all of the body except the right lobe of the liver, right arm, and right side of the head, neck and thorax, including the right lung and right side of the heart. The smaller duct is the right lymphatic duct. Both ducts empty lymph into the venous circulation of the body.

Lymph nodes

Along the lymphatic vessels, at various intervals, are small structures known as lymph nodes. The nodes consist of an inner core of lymphatic tissue surrounded by a fibrous capsule. The lymph nodes act as a filter, removing foreign substances from the lymph as it passes through the nodes. In healthy people, the lymph nodes usually go unnoticed. However in certain diseases, such as lymphogranuloma venereum or plague, the lymph nodes may become swollen, painful, and hard due to infection.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

019. Mechanics of immunity

1. What is natural resistance?

2. What are white blood cells called that engulf foreign substances?

3. Give three examples of anatomic natural defense mechanisms.

4. Give three examples of chemical natural defense mechanisms.

5. Define acquired immunity.

6. In naturally acquired passive immunity, how does the fetus acquire antibodies from its mother?

7. Why is passive immunity especially important to the newborn?

8. Why are passive immunizations used in conjunction with active immunizations?

9. What is active immunity?

10. What type of immunity is the result of a natural infection?

11. Give two examples of diseases that produce a short-lived immunity and two examples of those producing life-long immunity.

020. Serology

1. Name three diseases that can be diagnosed by serology.

2. Define antibody titer.

3. What happens to the antibody titer in response to infection?

4. What two patterns of an antibody titer are characteristic of active infection?

5. What is an antigen?

6. What is a synonym for antibody?

7. What are the five identified classes of immunoglobulins?

8. Most antibody activity in human serum is due to what three classes of immunoglobulins?

9. On the first contact with a particular antigen, what antibody is produced first?

10. On a second or subsequent contact with an antigen, what antibody predominates?

11. Which antibody crosses the placenta and is responsible for protection of the newborn?

12. Which immunoglobulin is the primary responder to entry of pathogens through the respiratory or gastrointestinal tracts?

13. Which two classes of immunoglobulins are found in minute quantities in the serum?

021. Immune system cells and tissues

1. Lymphocytes develop into what two types of cells?

2. The B-lymphocyte can further differentiate into what two types of cells?

3. What does a B-lymphocyte produce in response to an antigen?

4. Cellular immunity is the basis of which type of cell?

5. Which cell is destroyed by the human immunodeficiency virus?

6. Which cell is involved in the tuberculosis skin test positive reaction?

7. What are the structures of the lymphatic system?

Answers to Self-Test Questions

009

1. The arms and legs.
2. The clavicle (collarbone) and the scapula (shoulder blade).
3. Tendons.
4. Small pieces of bone and bone chips are created through a fracture.
5. A large mass of loosely woven bone forms and is remodeled according to the stresses acting on the bones.

010

1. The sliding filament mechanism.
2. High myoglobin content.
3. Aspartate amino transferase (AST).
4. (1) Loss of nerve supply to the muscle and (2) lack of use.
5. A disease affecting muscles of both animals and man and is caused by eating meat containing infective trichinella cysts.

011

1. To help regulate body temperature.
2. Red blood cells (RBC).

3. Anemia.
4. Group B.
5. Rh antigen.
6. The pericardium.
7. Left atrium.
8. Shock.

012

1. Turbinates.
2. Cricothyrotomy or tracheotomy.
3. Trachea or windpipe.
4. Diaphragm.
5. Pneumothorax.
6. Pulmonary edema.

013

1. (1) Breakdown (mechanical and chemical), (2) absorption, and (3) elimination of wastes.
2. The alimentary canal and the accessory glands.
3. Gravity and muscular contractions.
4. Villi.
5. The large intestine.
6. The parotid salivary glands.
7. The liver.
8. Jaundice or yellowing of the skin and eyes.

014

1. 1 ml.
2. The body is dehydrated and the kidney is functioning normally.
3. Scrotum.
4. Final maturation and storage of sperm.
5. Testosterone.
6. Facial hair, deepening voice, and increased musculature.
7. Ovaries.
8. Estrogen.
9. The maturing of oogonia by a series of cell divisions into a mature ovum.
10. From 24 to 72 hours.
11. Gametotoxins.

015

1. Negative feedback.
2. The pituitary gland.
3. Hyperthyroidism.
4. Adrenal glands.
5. Lutenizing hormone (LH).
6. Enables the tissues of the body to metabolize sugar circulating in the bloodstream, thus lowering blood sugar levels.

016

1. Axons.
2. Central nervous system and the peripheral nervous system.
3. Brain and spinal cord.
4. Frontal, parietal, temporal, and occipital.
5. The meninges.
6. Motor nerves.
7. Acetylcholine.
8. Acetylcholine esterase.

017

1. (1) Sensation, (2) protection, (3) secretion (sebum and sweat), and (4) temperature regulation.
2. Up to 4 liters per hour.
3. Reddening of the skin.
4. A blister or elevation filled with fluid, not pus.
5. A reddened, solid elevation of the skin.

018

1. The sclera.
2. The retina.
3. Myopia.
4. A biconvex lens.
5. Eustachian, or auditory, tube.
6. Hearing and equilibrium.
7. Vertigo.

019

1. Immunity dependent on some special anatomical or physiological property of an animal species rather than a specific antibody.
2. Phagocytes.
3. (1) Physical barrier of the skin, (2) phagocytes, and (3) sweeping action of the cilia in the respiratory tract.
4. (1) Lysozyme (enzyme), (2) interferon (antiviral agent), and (3) high acid content of stomach fluids.
5. An immunity that develops before birth and throughout the lifetime of the individual.
6. Across the placental barrier and through the mother's milk.
7. The newborn is incapable of producing antibodies of its own for a few months after birth.
8. For immediate temporary protection against diseases such as rabies and hepatitis B until the body can produce its own antibodies.
9. An immunity where the body actively produces antibodies in response to an exposure of an agent.
10. Naturally acquired active immunity.
11. Influenza and gonorrhea for short-lived immunity; while smallpox, mumps, measles, and chickenpox result in life-long immunity.

020

1. Any three of the following: (1) Syphilis, (2) hepatitis A or B, (3) rubella, and (4) rubeola.
2. It is the antibody level.
3. The titer rises or reaches a specific level.

4. An increase in titer over a period of weeks or a single sample that is a very high titer (such as a four times normal reading).
5. Any foreign substance that stimulates the body to produce an immune response.
6. Immunoglobulins.
7. (1)) IgG, (2) IgM, (3) IgD, (4) IgA, and)5_ IgE.
8. IgG, IgM, and IgA.
9. IgM is the first produced.
10. IgG is produced on subsequent contacts.
11. IgG protects the newborn.
12. IgA.
13. IgD and IgE.

021

1. B-lymphocytes and T-lymphocytes (B- and T-cells).
2. Plasma or memory cells.
3. Antibodies.
4. T-cell.
5. T helper cell.
6. T-cells.
7. Lymph capillaries, lymph vessels, lymphatic ducts, and lymph nodes.

Do the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter.

27. (009) Which is *not* part of the skeleton system?
    a. Bone marrow.
    b. Ligaments.
    c. Tendons.
    d. Blood.

28. (009) What type of fracture is characterized by small pieces or bone chips?
    a. Simple.
    b. Compound.
    c. Comminuted.
    d. Compression.

29. (010) What is the point on which applied muscle action results in motion?
    a. Attachment.
    b. Insertion.
    c. Origin.
    d. Belly.

30. (010) Which substance stores oxygen in the muscle tissue until it is needed by muscle cells?
    a. Actin
    b. Myosin.
    c. Enzymes.
    d. Myoglobin.

31. (010) Wasting away of muscle is called
    a. atrophy.
    b. hypertrophy.
    c. myoglobin reduction.
    d. Sliding filament mechanism.

32. (010) A disease affecting the muscles of both animals and man is called
    a. tuberculosis.
    b. trichinosis.
    c. influenza.
    d. hepatitis.

33. (011) Which cell makes up 99 percent of the total number of cells in the blood?
    a. White blood cells (WBC).
    b. Red blood cells (RBC).
    c. Lymphocytes.
    d. Platelets.

34. (011) The ABO blood group containing B antigens and anti-A antibodies is group
    a. A.
    b. B.
    c. AB.
    d. O.

35. (011) Which ABO blood group has *no* antigens, but *both* anti-A and anti-B antibodies?
    a. A.
    b. B.
    c. AB.
    d. O.

36. (011) Blood low in oxygen, returning from the body, enters which portion of the heart?
    a. Left atrium.
    b. Right atrium.
    c. Left ventricle.
    d. Right ventricle.

37. (012) The common passageway for both the respiratory and digestive systems is the
    a. pharynx.
    b. larynx.
    c. cricoid.
    d. trachea.

38. (012) Which part of the body causes the mechanics of breathing?
    a. Pharynx.
    b. Larynx.
    c. Diaphragm.
    d. Turbinates.

39. (012) Emphysema causes
    a. white blood cells and fluids to accumulate in the lungs, impairing gas exchange.
    b. destruction of lung tissue making less tissue available for gas exchange.
    c. an allergic response causing narrowing of the small airways.
    d. dry-land drowning from fluids due to choking agents.

40. (013) Protein digestion begins
    a. with the release of the enzyme pepsin in the stomach.
    b. by contact with hydrochloric acid in the stomach.
    c. when proteins enter the large intestine.
    d. when proteins enter the small intestine.

41. (013) A normal stomach ulcer occurs when
    a. the stomach becomes inflamed by of bacterial toxins or other irritants.
    b. the gastric secretion of hydrochloric acid stops.
    c. hydrochloric acid digests the stomach wall.
    d. blood vessels in the stomach wall erode.

42. (013) In which area of the digestive tract does the greatest nutrient absorption take place?
    a. Stomach.
    b. Cecum.
    c. Large intestine.
    d. Small intestine.

43. (013) An example of a vestigial organ is the
    a. stomach.
    b. cecum.
    c. appendix.
    d. pancreas.

44. (013) Which organ secretes digestive enzymes into the small intestine?
    a. Pancreas.
    b. Liver.
    c. Gallbladder.
    d. Appendix.

45. (014) How much filtrate does it take to produce approximately 1 ml of urine under normal kidney function?
    a. 50 ml.
    b. 125 ml.
    c. 200 ml.
    d. 275 ml.

46. (014) An indication that the body is dehydrated is when
    a. a very diluted urine forms.
    b. a very concentrated urine forms.
    c. the amount of reabsorption decreases.
    d. the kidney's ability to concentrate decreases.

47. (014) The meatus is part of which structure in the male?
    a. Testes.
    b. Urethra.
    c. Scrotum.
    d. Epididymis.

48. (014) Where does final maturation and storage of sperm take place?
    a. Penis
    b. Testes.
    c. Urethra.
    d. Epididymis.

49. (014) A common birth control method for males is performed on the
    a. testes.
    b. urethra.
    c. epididymis.
    d. vas deferens.

50. (014) What are the fringe-like structures that draw ovum into the fallopian tubes?
    a. Cilia.
    b. Oogonia.
    c. Fimbriae.
    d. Mycogenera.

51. (014) Which process is *not* continuous?
    a. Spermatogenesis.
    b. Menstruation.
    c. Oogenesis.
    d. Ovulation.

52. (014) On the average, on what day of the menstrual cycle does ovulation take place?
    a. Day 5.
    b. Day 10.
    c. Day 14.
    d. Day 28.

53. (014) At how many weeks in the development of a fetus are fingers and toes forming?
    a. 4.
    b. 5.
    c. 8.
    d. 12.

54. (014) Which substances disrupt the cell's DNA, resulting in a genetic defect?
    a. Teratogens.
    b. Mutagens.
    c. Carcinogens.
    d. Gametotoxins.

55. (014) Which substances reduce the numbers of sperm or ova in the body?
    a. Teratogens.
    b. Mutagens.
    c. Carcinogens.
    d. Gametotoxins.

56. (015) When there are adequate levels of thyroxine, the
    a. pituitary gland releases more thyroid stimulating hormone (TSH).
    b. thyroid automatically stops thyroxine production.
    c. pituitary gland stops producing TSH.
    d. thyroid produces more thyroxine.

57. (015) Which hormone promotes milk production in the female?
    a. Oxytocin.
    b. Prolactin.
    c. Corticotropin.
    d. Lutenizing hormone.

58. (015) Which hormone promotes uterine contractions?
    a. Oxytocin.
    b. Prolactin.
    c. Antidiuretic hormone.
    d. Letenizing hormone

59. (015) What is the condition where too much thyroxine is produced?
    a. Goiter.
    b. TSH deficiency.
    c. Hypothyroidism.
    d. Hyperthyroidism.

60. (015) The substance responsible for the body's fight or flight response is produced in the
    a. pituitary gland.
    b. adrenal glands.
    c. pancreas.
    d. thyroid.

61. (016) What are the processes that carry impulses away from the cell body?
    a. Axons.
    b. Dendrites.
    c. Synapse.
    d. Villi.

62. (016) Which contains insulating myelin coatings and is found in the spinal cord?
    a. Gray matter.
    b. White matter.
    c. Parietal lobes.
    d. Meninges.

63. (016) Frontal and temporal lobes are found in the
    a. meninges.
    b. cerebrum.
    c. spinal cord.
    d. peripheral nervous system.

64. (016) What protects the brain beneath the skull and the spinal cord beneath the vertebral column?
    a. Meninges.
    b. Cerebrum.
    c. Myelin coating.
    d. Occipital lobes.

65. (016) What allows the electrical charge to cross the crevice between neurons?
    a. Acetylcholine.
    b. Dendrites.
    c. Axons.
    d. Villi.

66. (017) Reddening of the skin is called
    a. dermatitis.
    b. erythema.
    c. induration.
    d. vesicle.

67. (017) A blister or elevation filled with fluid, not pus, is a
    a. pustule.
    b. papule.
    c. macule.
    d. vesicle.

68. (017) What is a flat, reddened spot on the skin?
    a. Papule.
    b. Pustule.
    c. Macule.
    d. Ulcer.

69. (018) The white protective layer on the outside of the eyeball is the
    a. sclera.
    b. retina.
    c. cortex.
    d. cornea.

70. (018) What is the opening of the eye?
    a. Sclera.
    b. Iris.
    c. Pupil.
    d. Cornea.

71. (018) The rods and cones within the eye are located in the
    a. retina.
    b. sclera.
    c. pupil.
    d. cornea.

72. (018) What is another name for myopia?
    a. Farsightedness.
    b. Nearsightedness.
    c. Astigmatism.
    d. Cataracts.

73. (018) Which structure within the ear is important for equalizing pressure between the middle ear and the outside environment?
    a. Cochlea.
    b. Ossicles.
    c. Tympanic membrane.
    d. Eustachian Tube.

74. (019) Which is an example of an anatomical defense mechanism?
    a. Lysozyme.
    b. Interferon.
    c. Stomach acids.
    d. Phagocytes.

75. (019) Which type of immunity is acquired when an infant receives immunity from its mother?
    a. Artificially acquired active immunity.
    b. Naturally acquired active immunity.
    c. Naturally acquired passive immunity.
    d. Artificially acquired passive immunity.

76. (019) Which immunity produces antibodies following an actual infection?
    a. Artificially acquired active immunity.
    b. Naturally acquired active immunity.
    c. Artificially acquired passive immunity.
    d. Naturally acquired passive immunity.

77. (020) Which immunoglobulin is the most abundant?
    a. IgM.
    b. IgG.
    c. IgA.
    d. IgD.

78. (020) Which antibody is usually the first to respond to an infection?
    a. IgM.
    b. IgG.
    c. IgA.
    d. IgD.

79. (020) Which immunoglobulin usually responds to respiratory and gastrointestinal tract infections?
    a. IgM.
    b. IgG.
    c. IgA.
    d. IgE.

80. (021) What produces chemicals that recruit other cells such as phagocytes in the immune response?
    a. B-Lymphocytes.
    b. T-Lymphocytes.
    c. Plasma cells.
    d. Lymph vessels.

81. (021) Lymph vessels empty into which structure?
    a. Lymphatic ducts.
    b. Lymph capillaries.
    c. The aorta..
    d. The liver.

Please read the unit menu for unit 4 and continue ➔

Student Notes

Unit 4. Medical Records

AS you've already learned, our career field requires knowledge of many medical terms and concepts. Undoubtedly, you'll be required to read medical records or even write in a patient's record during your career.

4–1. The Medical Environment

This section explains some of the more common medical terms and abbreviations. Occasionally rereading this section will help you remember these terms.

022. Medical terminology

This lesson covers the terms used to describe locations or directions on the human body as well as common root words, prefixes, and suffixes found in medical terms.

Locational terms

The human body can be divided several ways to describe the location of a particular portion of the body. These divisions include the mid-sagittal, transverse, and coronal planes. A directional term is usually associated with the use of one of these planes. These directional terms are covered as you study the respective planes.

Mid-sagittal plane

The mid-sagittal plane is an imaginary plane that extends the length of the body, dividing it into equal right and left portions. The directional terms used with this plane are usually medial and lateral. Medial describes a point closest to the mid-sagittal plane. Lateral describes a point further away from the mid-sagittal plane (fig. 4–1). For example, the ear is lateral to the eye, and the nose is medial to the eye.

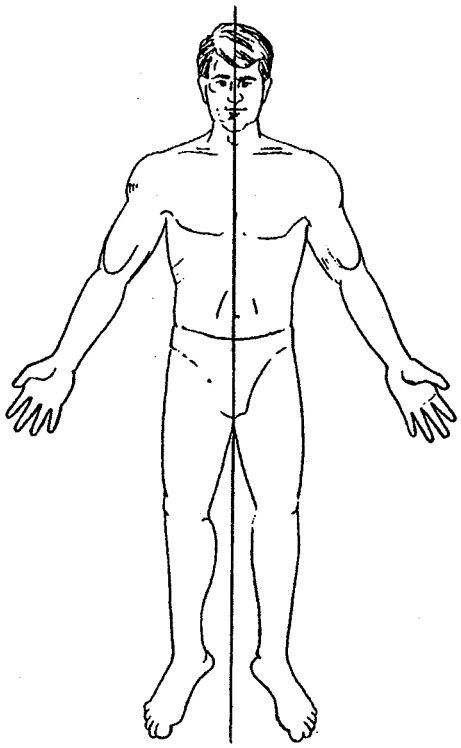


Figure 4–1. Mid-sagittal plane.

Transverse plane

A transverse plane is an imaginary plane that extends the width of any portion of the body dividing it into upper and lower portions. The directional terms used with this plane are superior (means a point above) and inferior (means a point

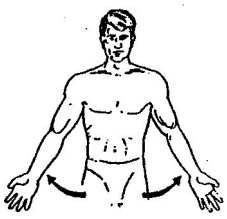
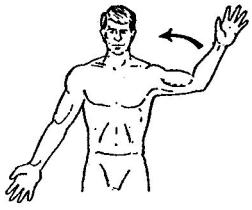
below another point on the body). For example, the chest is superior to the abdomen, while the genitals are inferior to the abdomen.

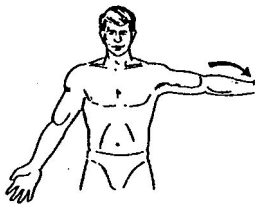
Coronal plane

The coronal or frontal plane is an imaginary plane that extends the length of the body dividing the body into front and back portions. The directional terms used with this plane are anterior (means to the front) and posterior (means to the back of the coronal plane). For example, the nose is anterior to the esophagus, while the buttocks are posterior to the esophagus.

Other directional or locational terms

There are some other terms used to describe direction or location, which are explained in the following table:

Term	Definition	
Point of origin	Is the beginning of an extremity or system. For example, the mouth is the point of origin for the digestive system. Directional terms associated with the point of origin are proximal (closest to the point of origin) and distal (furthest away from the point of origin). The stomach is proximal and the anus is distal to the mouth.	
Unilateral and bilateral	Unilateral means affecting only one side of the body or one of a pair of body organs. Bilateral means affecting both sides of the body or both pairs of body organs. A bilateral ear infection affects both ears.	
Adduction	Movement toward the mid-line of the body	 ***adduction*** **Figure 4–2a. Adduction.**
Abduction	Movement away from the mid-line of the body.	 ***abduction*** **Figure 4–2b. Abduction.**
Flexion	Movement to *close* an angle such as the arm movement in a salute (closes the elbow joint).	 ***flexion*** **Figure 4–2c. Flexion.**

Term	Definition	
Extension	Movement to *open* an angle such as reaching out with your arm to turn on a light (opens the elbow joint)	 ***extension*** **Figure 4–2d. Extension.**

Root words

Roots form the basis for word meanings. If you can recognize the root of many medical terms, you may be able to determine the meaning of the whole word. Some of the more common root words used in medical terminology are explained in the following table:

Root	Meaning	Example
Aden	Gland	Adenectomy means removing a gland.
Adip	Fat	Adipose means of a fatty nature.
Arteri/o	Artery	Arteriogram is a test which traces the pulse in an artery by means of radiography.
Cephal	Head	Cephalgia is a headache.
Chondri	Cartilage	Subchondral means under the cartilage.
Cost	Rib	Epicostal means upon the rib.
Crani	Skull	A craniectomy would be the surgical removal of the skull.
Cyst	Bladder	Cystitis is inflammation of the urinary bladder.
Derma or dermat/o	Skin	Dermatology is the study of the skin.
duct	Tube	An oviduct is a tube through which eggs pass.
Gastr	Stomach	Gastritis is an inflammation of the stomach.
Gen	To produce	Carcinogen is something which causes cancer.
Glossal	Tongue	Glossalgia means a pain in the tongue.
Hepat	Liver	Hepatitis is inflammation of the liver.
Myo	Muscle	The myrocardium is the heart muscle.
Nephr (more commonly used) and ren	Kidney	Nephritis is an inflammation of the kidney. “Ren” is used with the suffix “al” as in renal.
Neuro	Nerve	A neurocyte is a nerve cell.
Opthalm	Eye	An opthalmologist is a physician who specializes in the eye and its pathology.
Oste	Bone	Ostectomy is bone removal.
Ot	Ear	An otoscope is the instrument used to see inside the ear.
Ov	Egg	Ovarigenic means originating in the ovary.
Thrombo	Blood clot	A thrombosed vein contains clotting cells or thrombocytes.
Vas	Vessel	Vascularization is the development of blood vessels in tissue. A vasoneuropathy is any nerve and vessel disease.

Prefixes

Prefixes are beginnings of words. If you can recognize the root word and its prefix, you may be able to figure out the meaning of a medical term. Some of the more common prefixes and examples of their use are explained in the following table:

Prefix	Meaning	Example
A or an	Without	Abrachial means without an arm, and anorexia means without appetite.
Ad	To or toward	Adneural means toward a nerve.
Ante	Before	Antebrachial means before the forearm.
Bi	Two	Bisection means cutting into two parts.
Bio	Life	Biology is the study of life.
Epi	Upon or on	Epispinal means upon the spine.
inter	Between	Intercostal means between the ribs.
intra and endo	Within	Intracranial and endocranial both mean within the skull.
Erythr/o	Red	An erythrocyte is a red blood cell.
Hem/o or hemat	Blood	Hematology is the study of blood.
Hyper	Above or an excess	Hypertension is elevated blood pressure.
Hypo	Below or deficient	Hypoglycemia is deficient blood sugar.
Leuk/o or leuc/o	White	A leukocyte is a white blood cell.
Peri	Around	Pericardium means around the heart.
Pneum/o or pneumon/o	Refers to air, breath, or lungs.	Pneumonitis is an inflammation of the lung, and pneumothorax is a build up of air outside of the lungs in the thoracic cavity.
Retro	Behind	Retronasal means behind the nose.
Sub	Under	Subcutaneous means under the layer of skin.

Suffixes

Suffixes are endings of words. If you recognize both the root word and its suffix, you may be able to determine what a specific medical term means. Some of the more common medical suffixes with examples of their use are explained in the following table:

Suffix	Meaning	Example
algia	Pain	Arthralgia is painful joints.
blast	Forming cell	An erythroblast is a newly forming red blood cell.
cyte	Cell	Leukocytes and erythrocytes are blood cells.
ectomy	Surgical removal of a part of the body	A pneumonectomy is the removal of a lung.
itis	Inflammation	Otitis is inflammation of the ear.
logy	Study of	Neurology is the study of nerves.
osis	Condition of	Dermatosis means any skin disease which is not characterized by inflammation.
pathy	Disease	Dermopathy is a disease of the skin.
scopy	Visual examination of	Endoscopy is the visual examination of the inside of a body organ.
stasis	Standing still	Hemostasis means blood that is not moving properly through the circulatory system.
stenosis	Narrowing	Arteriostenosis means narrowing of the arteries.
tomy	Surgical incision	A cystotomy is the surgical incision into the bladder.

Other word endings

Other word endings can be used to make a word a noun, an adjective, or a word meaning *pertaining to*. For example, the root word for heart is *card*. Nouns often end with either *um* or *ium*. So the noun form of the word for heart muscle becomes myocardium. The root becomes an adjective with the addition of the suffix *al*—ardial, as in mycocardial attack. Words ending with *ac* mean *pertaining to*—cardiac means pertaining to the heart.

Medical abbreviations

Use of abbreviated terms is a timesaver. Abbreviations generally help medical personnel document large amounts of information without completely writing out all of the details word by word. Only specific abbreviations are authorized for use and some of the more common follow:

q.d., b.i.d., t.i.d., and q.i.d.

If a patient's medication was labeled one tablet q.d. the medication should be taken once daily. The abbreviation b.i.d. means twice per day, t.i.d. means three times per day, and q.i.d. means four times per day.

With and without

The symbol that means with is a *c with a line over it.* This comes from the Latin word con meaning *with*. The symbol that means without is an *s with a line over it*. This is from the Latin word sin meaning *without*.

P.O.

P.O. is from the Latin "per os" that means *mouth or orally*. If a doctor writes two tabs P.O. t.i.d., the patient would take two tablets orally three times per day.

Other abbreviations

Hx means *history*, and c/o or c/c means *complains of* or *chief complaint*. The symbol for *male* is an O with an arrow pointing at a 45° angle from it, and the symbol for *female* is the same circle with a cross pointing directly down from the bottom. The provider may request a B/P meaning *blood pressure* and a T.P.R. meaning *temperature, pulse, and respiration* on a patient. S&S means *signs and symptoms*. The abbreviation for left eye is O.S., while the abbreviation for *right eye* is O.D. The physician may develop an IMP, meaning *impression* of the patient, or may want to R/O or *rule out* a specific Dx or *diagnosis* such as "common cold R/O allergy." Test results may be WNL meaning *within normal limits* or TNTC meaning *too numerous to count*. If the patient is on medication, the doctor may increase medication using an upward arrow pointing (↑) or may decrease medication using a downward pointing arrow (↓).

For other terms and abbreviations not covered here, consult a medical dictionary or ask for assistance from your local medical administration office.

023. Medical ethics

Ethics are [moral principles or values held by a group, person, or profession. Ethical behaviors are the established standards of behavior to be followed by everybody within a specific group, such as the health care professions. One ethical behavior for medical personnel is to maintain patient confidentiality. On those occasions when you have access to medical records or discuss personal information with patients, you must protect this information from public disclosure.

Working and patient relationships

Your job requires you to work with many people in the medical and nonmedical communities. These relationships are very important to establish your professional credibility. However, it only takes one incident of unprofessional behavior to ruin that trustworthiness.

One of the most important relationships you have is with your patients. Your confidence, combined with a sensitive and honest approach, should reassure them they are receiving the best professional care. The patient trusts you to keep sensitive information confidential. Since your training has made you more knowledgeable about preventive health procedures than the average person, you must determine what information your patients need and educate them whenever possible.

Release of information (judicial sanctions)

AFI 37-132, *Air Force Privacy Act Program*, covers the release of medical and other personal information. Two helpful principles to remember in this regard are (1) *keep disclosure to a minimum* and (2) *release information only to those parties who have a legitimate need to know*. These people could include, but are not limited to, the patient, the patient's primary health care provider, and other health care personnel; medical inspectors and statisticians; and special agencies such as the AFOSI; and federal, state, or local public health offices. Patients must provide written consent for release of information to their insurance companies, legal representatives, and other third parties.

Public Health does not release medical information unless directed by higher headquarters or by regulation. The Patient Affairs Office is the official office of release for medical information. Although not considered an invasion of privacy, do not release other personal information, such as date of birth, marital status, and date of rank, to anyone who does not have an *official need to know*. Release of a person's home telephone number, home street address, or social security number is definitely considered an invasion of privacy.

Individual state laws could affect the release of specific medical information regarding minors, drug and alcohol abuse, abortions, and teenage pregnancy. Make sure you know the laws of your state.

There are civil remedies and criminal penalties for violating privacy act information. An individual can file a civil suit against the Air Force for failing to comply with the Privacy Act. A military person can be found guilty of a misdemeanor and fined not more than $5,000 for willfully disclosing information to someone who is not entitled to it or obtaining medical records under false pretense.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

022. Medical terminology

1. Which body plane is an imaginary plane that extends the length of the body, dividing it into equal right and left portions?

2. What does medial mean?

3. What is a coronal plane?

4. What does adduction mean?

5. What does the root word *adip* mean?

6. Cystitis is an inflammation of what?

7. What does the root *oste* mean?

8. What does the prefix *peri* mean?

9. What does the prefix *endo* mean?

10. What is a leukocyte?

11. What does the suffix *algia* mean?

12. What does the suffix *stenosis* mean?

13. What does the word ending *ac* mean?

14. What is the abbreviation for taking medication by mouth or orally?

15. What is the abbreviation for a person's right eye?

023. Medical ethics

1. What are ethics?

2. What AF instruction covers the AF Privacy Act program?

3. Which offic has the official responsibility for releasing medical information?

4. What is the maximum fine for willfully disclosing information to someone who is not entitled to this information?

4–2. Medical Record Documentation

You've read about medical terminology and ethics used in medical professions. This section teaches you about the medical records used to document the patient's medical problems. There are specific guidelines for documenting medical records. Most of the forms are legally binding and admissible in a court of law. Rules for documenting are standardized so that all health care personnel can easily read the record. You should be able to find and read specific patient information to effectively perform your duties.

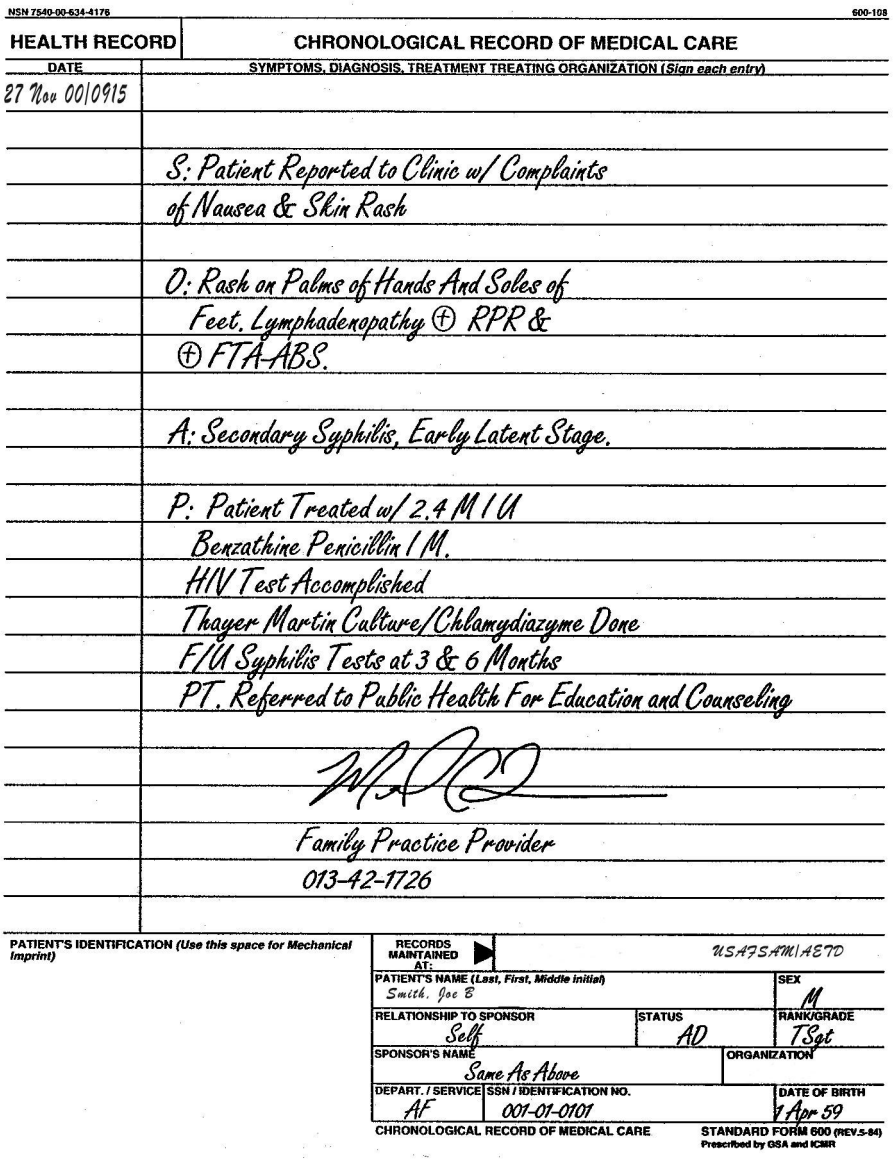
024. Medical records—types and documentation

Before you learn about the forms associated with the communicable disease program that are found in medical records, you must be able to identify the different types of medical records. They include the inpatient record used for hospitalizations, dental record, and outpatient record, which is most frequently used by medical personnel. The patient's full name with sponsor's social security number must appear on each form in the record. Family prefixes include the following: "20" preceding the social security number indicates the record is for the sponsor; "30" indicates spouse; and "01" indicates the first child, "02" the second child, and so on. The record should also be marked to show the patient's drug allergies as well as some specific treatments such as isoniazid for exposure to tuberculosis or specific chemotherapies for the treatment of cancer.

In addition to its use for documenting patients' medical problems or progress, the medical record is used as a communication tool among health care providers. As a legal form, entries must reflect that an organized and scientific approach was used to diagnose and treat the patient. Each entry includes the date and time of entry and is written in black, blue, or blue-black reproducible ink. Entries must be legible with correct grammar, spelling, and the author's signature. Correct mistakes legibly with a single line through the mistake and the author's initials signed above the correction. Original copies of all forms should remain in the medical record; if this not possible, photo or carbon copies are acceptable documents.

SF 600, Chronological Record of Medical Care

This form (fig. 4–3) is the most often used form in the medical record.



NSN 7540-00-634-4176 600-108

HEALTH RECORD — **CHRONOLOGICAL RECORD OF MEDICAL CARE**

DATE	SYMPTOMS, DIAGNOSIS, TREATMENT TREATING ORGANIZATION (Sign each entry)
27 Nov 00/0915	S: Patient Reported to Clinic w/ Complaints of Nausea & Skin Rash O: Rash on Palms of Hands And Soles of Feet, Lymphadenopathy ⊕ RPR & ⊕ FTA-ABS. A: Secondary Syphilis, Early Latent Stage. P: Patient Treated w/ 2.4 M I U Benzathine Penicillin I M. HIV Test Accomplished Thayer Martin Culture/Chlamydiazyme Done F/U Syphilis Tests at 3 & 6 Months PT. Referred to Public Health For Education and Counseling Family Practice Provider 013-42-1726

PATIENT'S IDENTIFICATION (Use this space for Mechanical Imprint)

RECORDS MAINTAINED AT: USAFSAM/AETD

PATIENT'S NAME (Last, First, Middle Initial)		SEX
Smith, Joe B		M
RELATIONSHIP TO SPONSOR: Self	STATUS: AD	RANK/GRADE: TSgt
SPONSOR'S NAME: Same As Above		ORGANIZATION
DEPART. / SERVICE: AF	SSN / IDENTIFICATION NO.: 001-01-0101	DATE OF BIRTH: 1 Apr 59

CHRONOLOGICAL RECORD OF MEDICAL CARE — STANDARD FORM 600 (REV.5-84) Prescribed by GSA and ICMR

Figure 4–3. Sample SF 600.

Subjective, Objective, Assessment, and Plan (SOAP) notes

On each SF 600, entries must follow a specific format to standardize documentation. This format is called SOAP, denoting subjective, objective, assessment, and plan entries (fig. 4–3).

Entry	Explanation
Subjective	Includes what the patient, family, or other observers say about the patient, such as "she's allergic to penicillin." All entries in this section must be relevant to the patient's problem and be concise, yet complete
Objective	Includes any observations made about the patient such as laboratory test results. You would also include any completed actions such as discussing preventive health teaching or completing patient contact interviews.

Entry	Explanation
Assessment	Is the professional opinion about the patient's problem based on the subjective and objective information previously gathered by the person making the entry. This section may be difficult to understand if it is a medical diagnosis made by a health care provider who used unfamiliar medical terminology and abbreviations. It is important to remember that a PH cannot make a medical diagnosis. A PH can make entries about the patient's knowledge of a disease process, methods to prevent the transmission of disease, or motivation to follow the health care provider's orders.
Plan	Is the plan or list of actions to help solve the patient's problem. This section must be specific and tell what, how, when, and any other pertinent information such as follow-up actions, if necessary.

Common errors made in SOAP entries include poor grammar, misspellings, and illegibility. Other errors include too general or too wordy entries and entries that do not pertain to the patient's problem. Significant problems also occur when PH personnel write a medical diagnosis in the assessment section.

025. Reviewing medical records

Your duties in Public Health require you to recognize and read many different forms contained in medical records. This lesson briefly covers the various forms used for communicable disease control and occupational health programs. Details pertaining to these forms are explained in subsequent volumes as they apply within each section.

Communicable disease forms

Some forms you'll see in the medical records are AF Form 2453, Tuberculosis Detection and Control Data; AF Form 570, Notification of Patient's Medical Status; as well as DD Form 2341, Report of Animal Bite - Potential Rabies Exposure. You'll also see some laboratory reports for tests ordered.

Reading laboratory results

You need to recognize various laboratory forms and test results. The most common forms that you'll need to know are chemistry, hematology, microbiology, miscellaneous, and urinalysis forms. Sometimes the lab personnel will circle or highlight test results that are abnormal. Also, the normal limits for various tests may differ depending on the procedures your lab uses. Check with your own laboratory for its normal numbers.

Form	Explanation
SFs 546, 547, and 548, Chemistry I, II, or III	Are used to request and report complex blood tests. The Chemistry I is used to request liver function tests when patients are taking isoniazid on the TB Detection and Control Program.
SF 549, Hematology	Is used to request and report blood cell counts. You may need to review this form in the occupational medicine program when employees are exposed to agents which could affect the blood cells.
SFs 553 and 554, Microbiology I and II	Are used to request and report the results of microbiological tests. The tests you will most often need to review are communicable diseases, mainly STDs. An example would be GC TNTC, which would mean Neisseria gonorrhea organisms that are too numerous to count. The Microbiology II is used for fungal smears and viral cultures. It is important to check the date of results if you are reviewing medical records for incoming personnels' exposure to communicable disease. You should be able to verify on the SF 600 Chronological Record whether the patient received adequate followup.
SF 557, Miscellaneous	Is used to request and report lab tests that are not performed on a routine basis, such as testing workers to determine if hazardous exposures have damaged their health status.

Form	Explanation
SF 550, Urinalysis	This Is used to request and report results of urological tests. These tests are for urinary tract infections, kidney infections, and urinary system function. It is used as part of an occupational examination when workers may be exposed to substances that are potentially nephrotoxic.

Other forms

Some other forms you may need to review are for radiology and special consultation.

SF 519, Radiologic Consultation Request/Reports

Review this form for patients either suspected of active tuberculosis or who were exposed to a person with active tuberculosis. The respiratory system is the target organ for the mycobacterium. This form is also used for requesting and reporting X rays for personnel on the occupational examination program. You may need to bring test results to the attention of the occupational health consultant. If you are performing an occupational trend analysis, you might compare chest X ray results for a group of employees assigned to the same workplace.

SF 513, Medical Record -Consultation Sheet

This form is used when one medical section needs the expertise of another medical section. If a physician suspects a patient's medical problem could be work-related, the physician refers the patient to PH using this form. You receive this form, investigate the workplace situation, and report to the requesting physician. The SF 513 is also used in the Fetal Protection Program to request PH input regarding potential duty restrictions for pregnant employees.

Occupational health forms

The second area you'll review records for is the occupational health program. You might perform a special trend analysis or review incoming personnel for prior exposures. You'll also see the SF 513, laboratory forms, and the radiological form SF 519 used for occupational health programs. One big area in the occupational health program is occupational illnesses and injuries.

ASIMS Occupational Illness Report

A physician who suspects an occupational illness or an occupational injury with chronic health consequences refers patients to PH for interview with an AF form 513. PH interviews the patient and consults with BioEnvironmental Engineering. A workplace evaluation may be necessary. If an occupational illness is validated, an Occupational Illness Report, found in the ASIMS AFRESS (Epi) Module, is completed. The form is fowarded to the appropriate agency automatically with the monthly ASIMS data transfer. The Occupational Illness and Injury Program is discussed in detail in volume 3.

Hearing conservation forms

All personnel enrolled in the Hearing Conservation Program should have these forms in their medical records.

Form	Use
DD Form 2215	Used to record all reference audiograms.
DD Form 22l6	If the employee experiences a significant hearing threshhold shift, subsequent l5- and 40-hour audiograms are recorded on this form.
AF Form l67l	If the patient requires a detailed followup, this form is used to request and record further audiologist evaluation.

Medical examination and history forms

Form	Use
SF Form 78, Certificate of Medical Examination	Completed for civilian workers' initial occupational medical examinations.
SF 88, Report of Medical Examination	Is completed for military patients' initial occupational medical examinations.
SF 93, Report of Medical History	Patients who provide a complete medical history do so on this form.
AF Form 1527, History of Occupational Exposure to Ionizing Radiation	Workers exposed to ionizing radiation complete this form.
AF Form 2755, Master Workplace Exposure Data Summary	Workers assigned to hazardous work areas surveyed by the BEEs have this form placed in their medical records, except those workplaces only exposed to hazardous noise.
AF Form 2768, Supplemental History	Local Aerospace Medicine councils determine which employees will have this form.
AF Form 2769, Supplemental Data Sheet	Is used to compare consecutive test results.
AF Form 2770, Assessment and Disposition	Is used to document whether an employee is returned to or removed from normal duty, based on exam results. A copy of this form is sent to PH for use in occupational trend analysis.
AF Form 422, Physical Profile Serial Report	Is used to temporarily or permanently limit a military person's duty. PH personnel see this most often for employees in the Fetal Protection Program.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

024. Medical records—types and documentation

1. What does a "20" in front of the social security number indicate?

2. What markings must be on the outside cover for specific treatments or exposures?

3. What is the most often used form in the medical record?

4. Which SOAP entry includes information given from a family member about a patient?

5. Which SOAP entry includes laboratory test results?

025. Reviewing medical records

1. What form is used for ordering complex blood tests?

2. What form is used for reviewing a result of a positive GC test?

3. What form would you review to find the result of a chest X ray?

4. What form should accompany a patient being referred to your office for a suspected occupational illness?

5. Which form would you review for a pregnant employee transferring to a new occupational shop?

Answers to Self-Test Questions

022

1. Mid-sagittal plane.
2. Describes a point closer to the mid-sagittal plane.
3. An imaginary plane that extends the length of the body dividing it into front and back portions.
4. Movement toward the mid-line of the body.
5. Fat.
6. The urinary bladder.
7. Bone.
8. Around.
9. Within.
10. A white blood cell.
11. Pain.
12. Narrowing.
13. Pertaining to.
14. P.O.
15. O.D.

023

1. The moral principles or values held by a group, person, or profession.
2. AFI 37-132, *Air Force Privacy Act Program*.
3. The Patient Affairs Office.
4. $5,000.

024

1. The record or document belongs to the sponsor.
2. Drug allergies, INH treatment, and specific chemotherapy for cancer.
3. SF Form 600, Chronological Record of Medical Care.
4. Subjective.

5. Objective.

025

1. Chemistry I, II, or III.
2. Microbiology I or II.
3. SF 519, Radiological Consultation Requests/Reports.
4. SF 513, Medical Record - Consultation Sheet.
5. AF Form 422, Physical Profile Serial Report.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to ECI Form 34, Field Scoring Answer Sheet.

Do not return your answer sheet to AFIADL.

82. (022) The imaginary plane that extends the length of the body dividing it into equal right and left portions is called
    a. mid-sagittal.
    b. transverse.
    c. coronal.
    d. frontal.

83. (022) Which term means movement *toward* the mid-line of the body?
    a. Abduction.
    b. Adduction.
    c. Flexion.
    d. Extension.

84. (022) Which prefix means upon or on?
    a. Intra.
    b. Endo.
    c. Inter.
    d. Epi.

85. (022) Which suffix means narrowing?
    a. Stenosis.
    b. Stasis.
    c. Algia.
    d. Osis.

86. (023) What is the *maximum* a military member can be fined for willfully disclosing information to someone not entitled to access or obtaining medical records under false pretenses?
    a. $1,000.
    b. $5,000.
    c. $10,000.
    d. $15,000.

87. (024) The prefix 20 in front of a social security number on a medical record indicates the record is for the
    a. spouse.
    b. second child.
    c. sponsor.
    d. first child.

88. (024) Which SF 600 entry includes what the patient says about a particular problem?
    a. Subjective.
    b. Objective.
    c. Assessment.
    d. Plan.

89. (024) Which SF 600 entry includes laboratory tests results?
    a. Subjective.
    b. Objective.
    c. Assessment.
    d. Plan.

90. (025) Reviewing medical records occurs in which section of Public Health?
a. All sections.
b. Communicable Disease Control.
c. Communicable Disease Control and Entomology.
d. Communicable Disease Control and Occupational Health.

Glossary of Abbreviations and Acronyms

ADP	adenosine diphosphate
AFOSH	Air Force Occupational Safety and Health
AIDS	acquired immumodeficiency syndrome
AMP	Aerospace Medicine Program
ASF	aeromedical staging flight
AST	aspartate amino transferase
ATP	adnosine triphosphate
CDC	Centers for Disease Control
CNS	aentral nervous system
CSF	aerebrospinal fluid
DNB	Disease nonbattle injuries
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
HBIG	hepatitis B immune globulin
HIV	human immunodeficiency virus
INH	Isoniazid
MMR	measles, mumps, rubella
MTF	medical treatment facility
NIOSH	National Institute of Occupational Safety and Health
OMG	objective medical group
OSHA	Occupational Safety and Health Administration
PH	Public Health
PNS	peripheral nervous system
PTF	Physiological training flight
RBC	red blood cells
RNH	Ribonucleic acid
SGOT	serum glutamic oxaloacetic transaminase
SOAP	subjective, objective, assessment, plan
STD	sexually transmitted disease

TNTC	too numerous to count
UA	urine analysis
USDA	United States Department of Agriculture
USDC	United States Department of Commerce
USDHHS	United States Department of Health and Human Service
USPHS	United States Public Health Service
WBC	white blook cells

Student Notes

AFSC 4E051
4E051 01 0104
Edit Code 02